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Heating · Piping and Air Conditioning

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ration•Maintenance
INDUSTRY AND
RGE BUILDINGS

July, 1935

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Testing and Instructing Pipe Welders

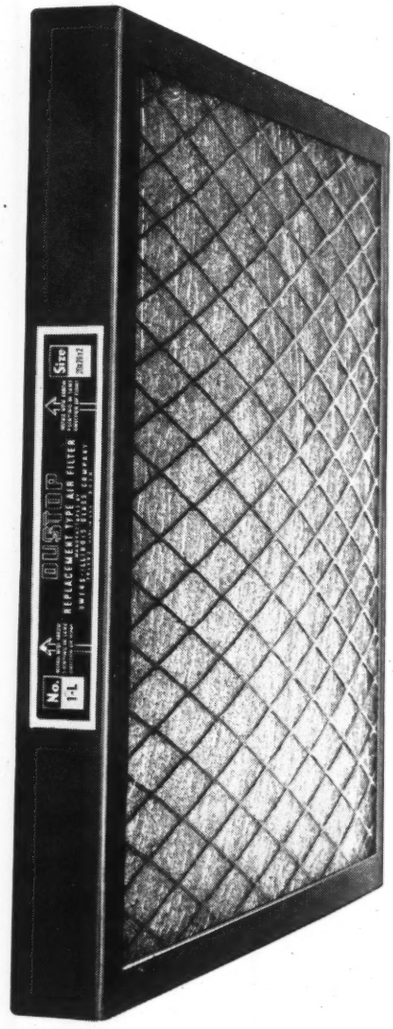
and others

Also the Journal Section of the American Society of Heating and Ventilating Engineers

If heat and moisture combined as spectacularly in air conditioning work as it does to form a geyser, importance of proper estimation of the sensible and latent heat loads in air conditioning design would be more clearly realized . . . see p. 317

Heating · Piping
and Air Conditioning

"CLEAN AIR
... give us Clean Air!"



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OWENS-ILLINOIS DUSTOP AIR FILTERS

THE EDITOR'S PAGE

THIS month—First of a series on air conditioning by Louis A. Harding leads off this month's issue; discussing the variable items in comfort cooling design, Mr. Harding points out why air conditioning bids vary, refers to the moot question of standards for air conditioning . . . Kalman Steiner concludes his description of the design and erection of a bulk fuel oil storage plant, explaining the determination of boiler capacity for supplying steam for heating the oil in the tanks to make economical pumping and handling possible . . . Believed to be the first case of "pneumatic installation" of building insulation in a new structure is the St. Paul post office building; D. W. Burnett describes how the job was done, estimates the consequent fuel saving . . . The distillation industry is paying particular attention to reduction of costs through recovery of valuable byproducts from waste; Warren Viessman describes the piping and drying equipment for byproduct recovery from whiskey still waste, presents plant operating results. Not only are salable byproducts recovered, but a problem in sanitation and public health is solved by the process . . . Operating time and trouble is saved, points out Sabin Crocker, if proper attention is given to installation of stokers in heating boilers; frequently all that is required is a little ingenuity, or a moderate investment in coal and ash handling equipment . . . While in South America on business, Rudolf Kuhlmann surveyed air conditioning installations in several cities; in his article this month, he describes the methods of conserving water required for air conditioning uses in Rio de Janeiro; U. S. engineers may soon need to give more attention to this phase of air conditioning, says Mr. Kuhlmann . . . A program of practical field testing and instruction of pipe welders is D. O. Ferguson's subject this month, concluding his informative article published last month . . . Modernizing buildings is briefly discussed in an article on page 339; recent raising of the FHA property improvement loan limit from $2000 to $50,000 is expected to open the way for financing installation of air conditioning equipment in numerous commercial buildings — restaurants, hotels, shops, stores, theaters, etc.— as investments in air conditioning are of a self-liquidating nature.

THE Journal Section of the *A.S.H.V.E.* this month includes three of the papers presented at the semi-annual meeting of the Society in Toronto—"Oil Burning in Residences", by D. W. Nelson; "Cooling and Air Conditioning in an Ale Brewery", by C. P. Creighton and F. J. Friedman; and "Classroom Drafts in Relation to Entering Air Stream Temperature", by F. C. Houghten, H. H. Trimble, Carl Gutberlet, and Merle F. Lichtenfels.

INDICATIONS point to a highly successful exposition of heating, ventilating and air conditioning equipment in Chicago next January, as space reservations for the Fourth International Heating & Ventilating Exposition are said to be ahead of expectations. The exhibit is to be held concurrently with the annual meeting of the *A.S.H.V.E.* . . . The meeting is scheduled for the Palmer House, and the exposition for the International Amphitheater . . . Set-up for the sponsoring of the Chicago "Standards for Certified Air Conditioning for Comfort" has been changed through the formation of the "Chicago Air Conditioning Advisory Council", headed by John Howatt, president of the *American Society of Heating and Ventilating Engineers*, and composed of representatives of the *Chicago Master Steam Fitters Association, Ventilating and Air Conditioning Contractors Association, Western Society of Engineers*, consulting engineers' association, *Illinois Society of Architects*, Illinois chapter of the *A.S.H.V.E., American Society of Refrigerating Engineers, Refrigerating Machinery Association*, and the *National Electrical Manufacturers Association*.

AT THE National Homes Conference held at Purdue University the first of last month it was announced that ten to twenty moderately priced homes would be built on a tract of 143 acres near the campus, will be rented to faculty members to provide a living laboratory of better housing conditions, complete studies of heating, ventilation, air conditioning, insulation, lighting, etc. . . . An "all weather laboratory" is also to be built, will hold an entire house, reproduce all sorts of weather conditions. An advisory council of prominent scientists and business men was appointed . . . Over 4,000 attended the second air conditioning show sponsored by the Public Service Co. of New Jersey at Newark last month; particular interest in winter air conditioning was evidenced, as well as in summer cooling . . . Connected horsepower for air conditioning added to the lines of the Commonwealth Edison Co., Chicago, for the first half of 1935 is double the figure for the corresponding period of last year . . . Air conditioning and industrial health, and occupational diseases, are on the program for the *American Public Health Association's* meeting in Milwaukee in October . . . Regulations for the installation of blower and exhaust systems for heating and ventilating, removal of flammable vapors, and conveying of dust, stock and refuse as recommended by the *National Fire Protection Association* have been approved by the *American Standards Association* as an American Standard . . . As part of its plan to enhance the professional status of the engineer, the *Engineer's Council for Professional Development* has undertaken to define minimum qualifications for education and experience . . . Among the significant resolutions adopted at the meeting of the *Heating, Piping and Air Conditioning Contractors National Association* in Cincinnati was "*Resolved*, that it is to the best interests of the industry that no heating, piping and air conditioning contractor will install any equipment that is not sold through the contractor making the installation". A resolution asking "proper recognition" of the contracting industry under the works relief bill was adopted . . . Basic reason for the increase in productivity during a period of business depression is not the mechanization of industry, but rather the drastic elimination of all waste, and rigid economies all along the line, practiced by industry as a whole as a means of maintaining markets in a period of declining demand, according to another in the series of studies made by the National Industrial Conference Board for the *National Machine Tool Builders' Association* . . . No question exists of the pent-up demand for durable goods, says the *Index* of the New York Trust Co.; a recent report of the *National Association of Manufacturers* declared that in the field of factory expansion, renovation, and rehabilitation alone there was room for expenditures of close to $20,000,000,000 and employment for 4,000,000 men for two years.

NOISE doesn't depend upon duct velocities but upon design, W. H. Driscoll pointed out during the discussion of air conditioning standards at the Toronto *A.S.H.V.E.* meeting . . . A Chicago organization has $3,000,000 ready to spend for air conditioning, said one speaker in stressing the need for standards . . . Studies of the effect of heat from the sun in increasing the cooling load during summer indicate that perhaps more attention should be paid to sun heat in winter as affecting design of heating plants, according to Samuel R. Lewis . . . Bypass patents—Claims Nos. 1, 3, 13, and 14 of the Lewis reissue patent No. 16,661 and Claims Nos. 1, 13, 14, 17 and 20 of the Fleisher patent No. 1,670,656 were decreed invalid for lack of invention by Judge Alfred C. Coxe, United States District Court, Southern District of New York, last month.

2 MORE FIELDS IN WHICH TONCAN IRON PIPE HAS PROVED ITS SUPREMACY...

There's an old saying, "One swallow does not make a summer." And by the same token, one fine record of service does not prove the superiority of a product. But when a product consistently shows longer life under certain conditions of service, that product must be eminently suitable for that kind of service. So it is with Toncan Iron Pipe in those uses where it comes in contact with salt or sulphur in solutions.

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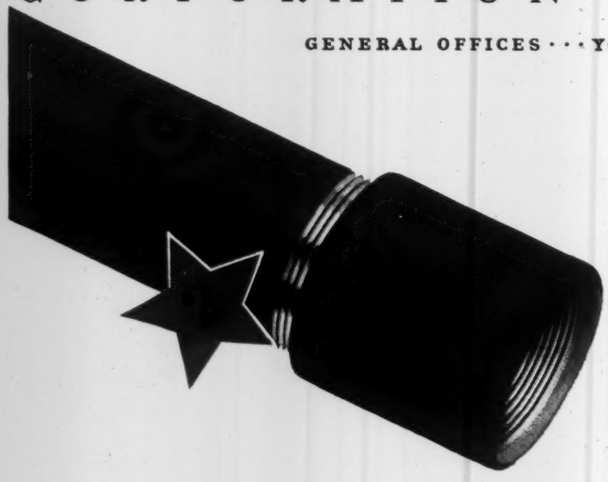

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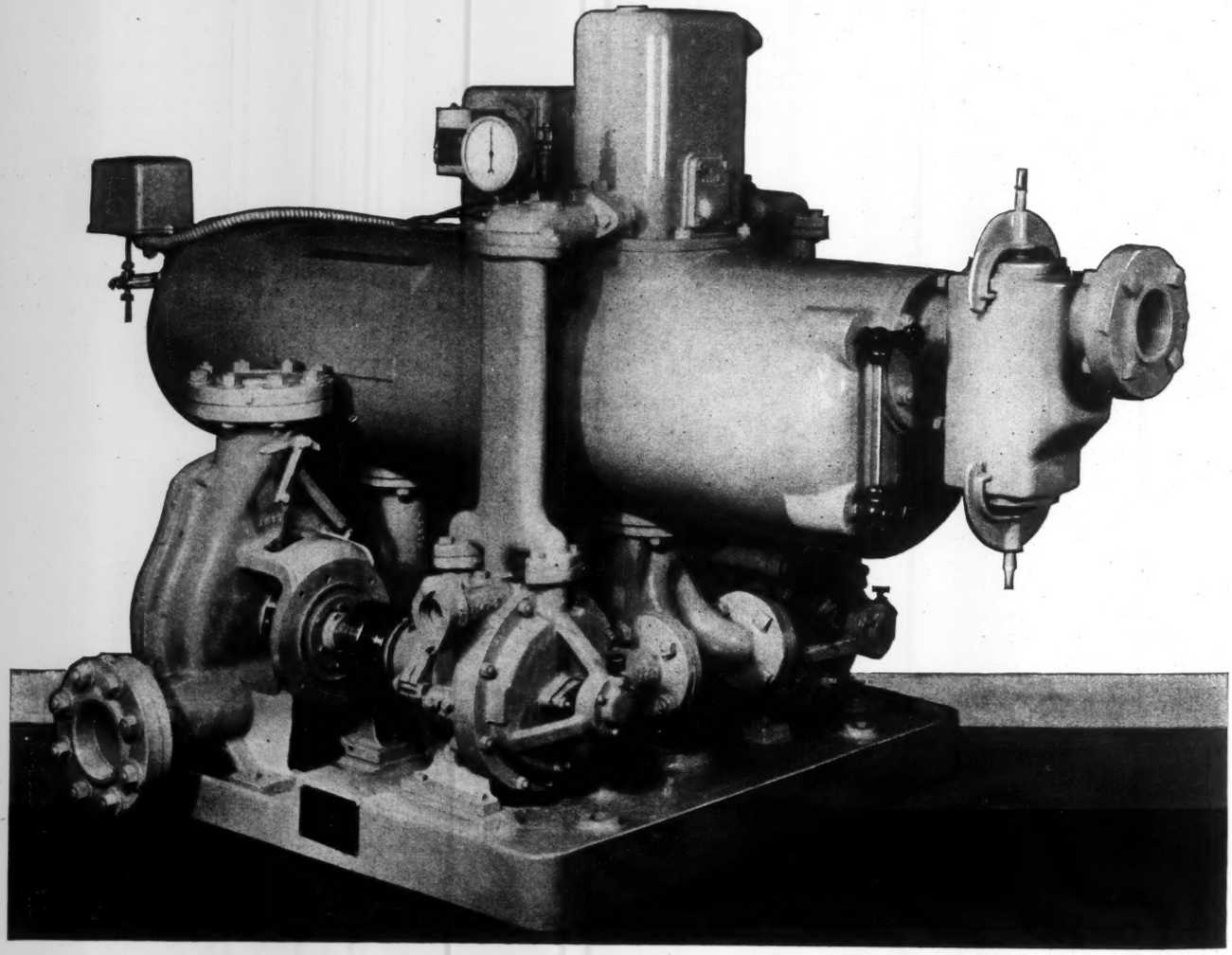


Heating · Piping and Air Conditioning

Vol. 7, No. 7 • July, 1935

Why Air Conditioning Bids Vary

—the Items in Comfort Cooling Design

By Louis A. Harding

of the L. A. Harding Construction Corp; past-president of the American Society of Heating and Ventilating Engineers; co-author of Harding and Willard's "Heating, Ventilating and Air Conditioning;" author of "Steam Power Plant Engineering" and the "Heating and Air Conditioning Manual"

OWNERS, architects and engineers requesting bids for summer comfort cooling equipment (when, as is quite usual, no plans or specifications are furnished to the bidders) frequently assert that they are at a loss to understand the wide divergence in the bids received. Quite generally they are under the impression that all the information that is necessary to furnish the bidders is the degrees of cooling desired (usually 10 to 15 F) when the outside temperature is specified. Occasionally the desired maximum inside dry and wet bulb temperatures or relative humidity are also stated.

The reason, as those familiar with the problem know, is due to the lack of adequate plans and specifications upon which competitive bidders can intelligently make an estimate. The number of assumptions which the designer must make before a tentative estimate may be completed precludes any possibility that any two bidders will by chance employ the same basic data throughout the computations. There is therefore a very considerable need to place limits on many of these variable assumptions which would, in a measure, result in better installations and more uniformity in competitive bids.

The recently issued "Standards for Certified Air Conditioning for Comfort" for Chicago are a step in the right direction. Standards should, however, not be so rigid as to prevent an owner from securing the most economical equipment based on an analysis of the investment involved and operating costs. The design which is the cheapest to install is generally not the one which will be the cheapest to operate.

The author is not laboring under the impression in the discussion which follows that he is presenting any particularly new ideas on the subject; the object is rather to discuss some of the variable items which are a part of the necessary formulas and equations involved in the design of cooling installations.

What Are the Basic Data?

The basic data, assuming the outside and inside air conditions as to temperatures and relative humidities have been agreed upon, include the sensible heat load, weight of vapor (moisture) to be removed (frequently termed the latent heat load), and the minimum dry bulb temperature of the chilled air to be introduced into the room. *Sensible heat* is defined as the heat required to change the temperature of a substance; as, for example, a mixture of air and vapor. The quantity of heat required is obviously the specific heat of the substance multiplied by the change in its temperature. The *latent heat* is the heat required to evaporate a liquid and produces no change in the temperature of the liquid.

Summer cooling may be thought of as the process involved to maintain the desired inside air temperature of an enclosure at a lower temperature than the outside air temperature, and implies the continual extraction of heat from the enclosure during the period when such temperature difference exists. The abstraction of the heat generated within an enclosure, heat passing through the walls of the enclosure from the outside and the heat introduced by the entering outside air either purposely for ventilation or by infiltration constitute the so-called sensible heat load.

Sensible Heat Load

This heat must be absorbed by the chilled air entering the room, in raising its temperature to the desired air temperature to be maintained at the breathing line. For all practical purposes the specific heat of the mixture of air and vapor, at constant pressure, for the customary temperature employed may be considered constant. The following well known formula embodies the preceding statements:

$$M = \frac{H_s}{0.24\ (t - t_3)} \qquad (1)$$

H_s = computed estimate of the heat (sensible) to be removed, Btu per hr (persons, lights, electrical apparatus, heat transmission, sun effect, infiltration, etc).

t = maximum design dry bulb temperature to be main-

tained for room air, F (usually 10 to 15 deg below outside design dry bulb temperature).

t_3 = minimum permissible dry bulb temperature of chilled air entering room.

0.24 = specific heat of air at constant pressure, Btu per lb.

M = weight of air to be circulated through room and cooling apparatus, lb per hr.

c = cfm standard air to be handled by fan.

$c = M/60 \times 0.075 = M/4.5$

It should be noted that the weight of air M is based on the sensible heat load to be removed *from the room.* It does not include the sensible heat to be removed in the cooler from the outside air drawn in for ventilating purposes at the cooler. The sensible heat to be removed by the cooler of course must include this item, as later noted.

Entering Air Temperature

It is evident that the design depends in large measure upon the value of t_3 assumed. The problem is removed from the cut and try process when t_3 is fixed and the various necessary computations involved to complete the work may proceed in an orderly manner.

If an uninsulated duct-distributing system is employed, t_3 should not be less than the dew point temperature of the air surrounding the duct in order to prevent the precipitation and consequent drip of moisture. If the duct system is located in the room being cooled, t_3 should not be less than the dew point temperature to be maintained in the room.

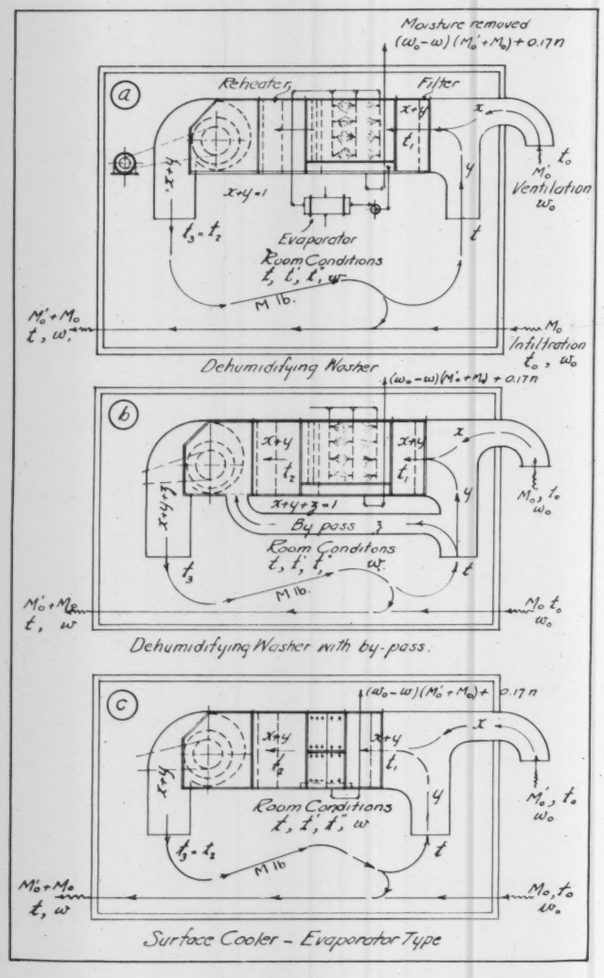


Fig. 1

Downward discharge duct outlets should of course, be provided with horizontal deflectors properly to diffuse the air entering the room and prevent the chilled air from descending on the heads of the occupants.

A rule-of-thumb method for limiting the minimum inlet temperature for air leaving duct outlets horizontally is; 2 deg per ft of height from floor to bottom of outlet below maintained room temperature.

The minimum permissible value for t_3 obviously results in a minimum cost for fan and duct work and required fan power. It depends entirely upon how effectively the chilled air is mixed with the room air before the resulting mixture reaches the occupants. The higher this temperature, the less likely the occupants will be subjected to cold drafts.

The designer obviously has the choice of employing a comparatively low temperature difference $(t—t_3)$ with accompanying high volume of air to be circulated with attendant higher initial cost of fan and duct installation or employing a higher temperature differential in order to decrease the initial investment. Initial cost of the duct work may, of course, be kept to a minimum by employing higher velocities than are commonly recommended. On the other hand, the owner must continually pay for the increased fan power necessitated by the increased duct resistance. The *minimum* volume and consequently the weight of air to be circulated through a room for comfort installations has been standardized by the A.S.H.V.E. ventilation code as 30 cfm (135 lb/hr) with 10 cfm (45 lb/hr) of outside air per person; in other words, the minimum amount of recirculated air is 20 cfm. The 30 cfm or 135 lb per hr may or may not be sufficient, depending upon the temperature differential employed and the sensible heat to be removed. To insure absence of body odors, 15 to 20 cfm outside air per person is recommended. Assume, for example, that the design is based on outside conditions of 90 F dry bulb, 74 F wet bulb, 67 F dew point and inside conditions of 80 F dry bulb, 67 F wet bulb, and 60 F dew point, (10 deg cooling) and that the occupants are at rest emitting approximately 220 Btu per hr per person (80 F air):

If we assume that the minimum requirements of the code obtain and that no other sensible heat load exists, we may write the equation,

$$0.24 \times 135\ (80 - t_3) = 220 + 0.24 \times 13.5\ (90 - 80)$$

in which $t_3 = 72$ F for the temperature of the chilled air entering the room. This is the highest possible temperature which the air may enter the room for conditions stated or an 8 F temperature differential $(t - t_3)$ in order to maintain the body thermal equilibrium. Obviously, if any additional sensible heat load exists, which is always the case, a lower inlet temperature is required, unless we increase the amount of air to be circulated or increase the temperature differential (lower t_3). The employment of comparatively high temperature differentials $(t - t_3)$ requires careful consideration of the air distribution in the room.

Incidentally, it is interesting to note that the heat

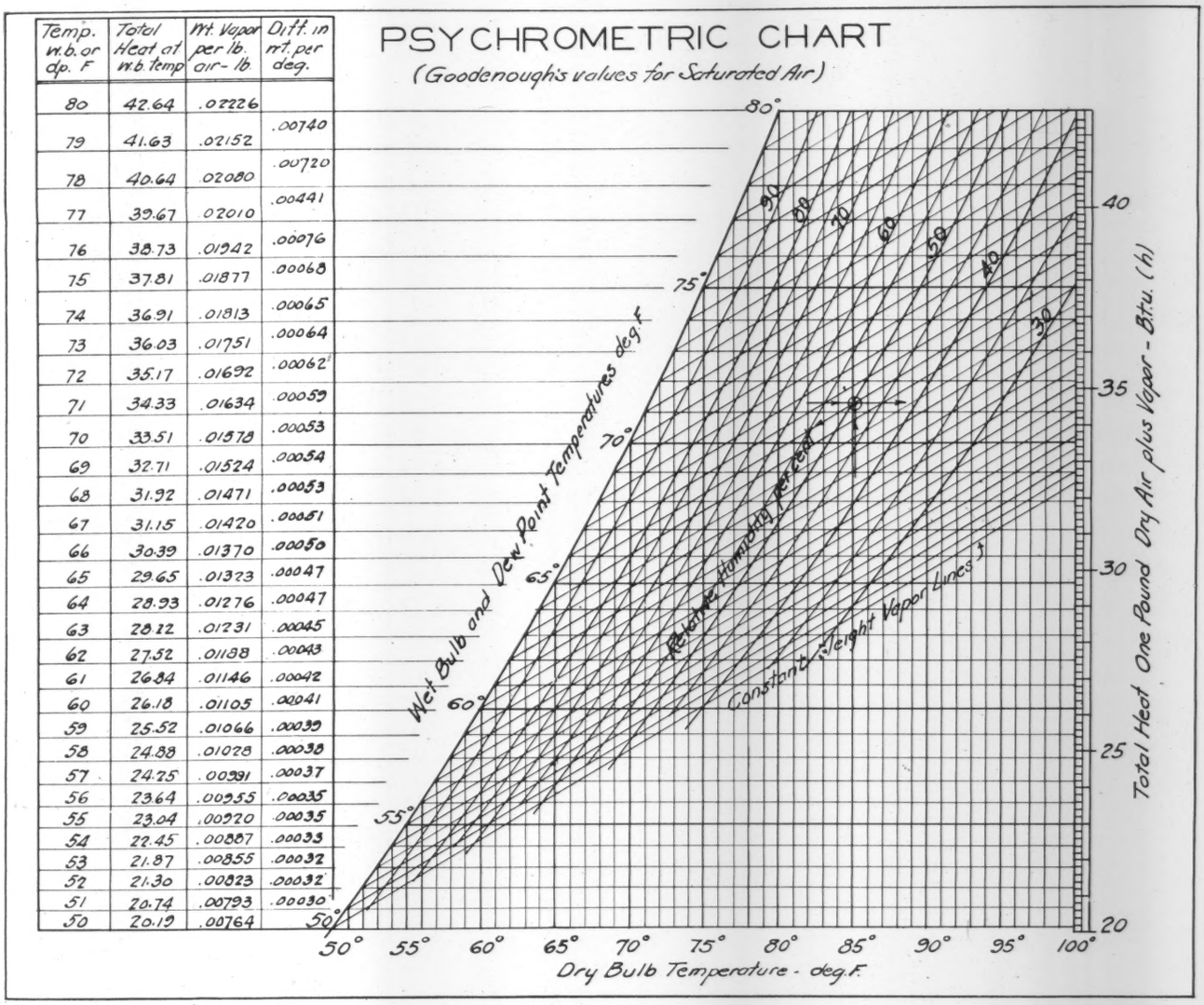


Fig. 2

energy generated (metabolism) by the consumption and combustion of foodstuffs per 24 hr day by the average man (sedentary occupation, 70 F air) is accounted for as follows:

Radiation and convection (sensible heat)	= 5,180 Btu
Evaporation of moisture	= 2,610
Locomotion (heat equivalent work)	= 1,190
Sedentary occupation (heat equivalent work)	= 1,580
Wastes in excrements	= 1,340
Total	11,900

This amount is the equivalent of 11900/3.968 = 3000 calories per day (consult your diet list). The average sensible heat loss is 5180/24 = 216 Btu per hr and the so-called latent heat loss is 2610/24 = 109 Btu per hr.

A low ceiling room provided only with wall outlets also requires careful consideration of the temperature differential and the design of adjustable diffusion vanes. The higher the outlet velocity, the better the opportunity for mixing and diffusing the chilled air with the room air before it reaches the occupants. At present there is no standard practice in respect to temperature differential for cooling installations and too frequently the air distribution is such that one does not feel equally comfortable in all parts of the room. It is expecting too much from a unit cooler installation without ducts to give entire satisfaction in all cases.

Air Outlet Temperature for Heating

After having fixed the volume and weight M of air to be circulated according to Equation (1), and assuming the same apparatus is to be employed for winter heating and humidification the air outlet temperature (t_4) for the design heating load H_1 is:

$$t_4 = t + \frac{H_1}{0.24M} \qquad (2)$$

t = maintained room temperature

A heater should be chosen which, for the steam pressure available, will deliver the air at approximately temperature t_4.

Weight of Moisture to be Removed

The next step is to determine the weight of moisture W in lb per hr to be removed by the cooling apparatus. The following notations will be employed:

t_o, t'_o, t''_o = outside air design temperature conditions for dry bulb, dew point, and wet bulb.

t, t', t'' = inside air design temperature conditions for db, dp and wb.

t_1, t'_1, t''_1 = temperature conditions air entering cooling apparatus for db, dp and wb.

t_2, t'_2, t''_2 = temperature conditions air leaving cooling apparatus for db, dp and wb.

t_3, t'_3, t_3'' = temperature conditions air entering room for db, dp and wb.

w_o, w, w_1, w_2, w_3 = weight of vapor per lb of dry air corresponding to the dew point temperatures with same subscripts, lb.

h_1, h_2 = total heat per lb of mixture of air and vapor entering and leaving cooling apparatus, Btu corresponding to wet bulb temperatures t''_1 and t''_2.

W_1 = weight of vapor added to the room air from occupants or other sources and by the infiltration air, lb per hr.

W_2 = weight of vapor added to the room return air by the ventilation requirements, lb per hr.

n = number of occupants. 0.17 = lb per hr of vapor given off per occupant (at rest in 80 F air).

M'_o = ventilating requirement, lb per hr ($60n$ × cu ft outside air per person × 0.075).

M_o = infiltration, lb per hr.

Then $W_1 = 0.17n + M_o\ (w_o - w)$. (3)

$W_2 = M'_o\ (w_o - w)$. (4)

The air must leave cooling apparatus and enter room with a weight of vapor per lb w_3 or

$$w_3 = w - \frac{W_1}{M} \tag{5}$$

The corresponding dew point temperature t'_3 is then determined by reference to the saturated air table.

For a dehumidifying air washer installation, Fig 1a, the air leaves the washer in a saturated condition at temperature t_2 which is the dew point temperature of the air entering the room or $t_2 = t'_3$. The saturated air in this case must be warmed by a heater or by mixing with room air bypassed around the washer to a final dry bulb temperature of t_3.

The dry bulb temperature (t_1) of air entering cooling apparatus by the method of mixtures is,

$$t_1 = \left[1 - \frac{M'_o}{M}\right] t + \frac{M'_o}{M}\, t_o \tag{6}$$

The weight of moisture per lb of air entering cooling apparatus by method of mixtures is,

$$w_1 = \left[1 - \frac{M'_o}{M}\right] w + \frac{M'_o}{M}\, w_o \tag{7}$$

corresponding to a dew point temperature of t'_1. The dry bulb temperature (t_1) being known, the wet bulb temperature (t''_1) is obtained by means of the psychrometric chart and consequently (h_1) is thus determined. The heat to be extracted from the air circulated by the cooling apparatus is therefore

$M\ (h_1 - h_2)$ Btu per hr *or*

$$\text{Tons of refrigeration} = \frac{M\ (h_1 - h_2)}{12{,}000} \tag{8}$$

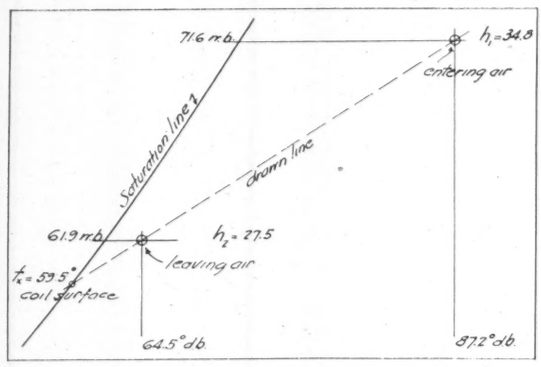


Fig. 3

It is obvious that the cooler must condense out the weight of vapor, $W_1 + W_2$ lb per hr. Also the cooler must remove the sensible heat load (H_S), plus the sensible heat load (H_V) to be removed from the air introduced for ventilation.

$$H_V = 0.24\ (t_o - t)\ M'_o \tag{9}$$

The latent heat load may usually be approximated with sufficient accuracy as; $H_L = 1060\ (W_1 + W_2)$ Btu per hr in which 1060 is the assumed latent heat of vapor at the temperature at which it is condensed. This assumption, of course, is not strictly correct.

For most practical purposes:

$$\text{Tons of refrigeration} = \frac{(H_S + H_V) + H_L}{12{,}000} \tag{10}$$

This approximation may be employed for either a bypass dehumidifying washer or surface cooling unit, but not for a dehumidifying washer without a bypass. In the latter case, the heat to be removed by the washer is somewhat greater.

Dehumidifying Washer With Bypass

To obviate the necessity of reheating the saturated air leaving the washer at dew point temperature (t'_2) to dry bulb temperature (t_3) and at the same time reduce the refrigeration required very materially, a return air bypass around the washer is essential.

Let x, y and z represent the fractional part of (M) that is outside air for ventilation, recirculated air through washer and bypassed air around washer respectively. ($x + y + z = 1$).

By method of mixtures we may write the equations,

$$zt + (x + y)\ t'_2 = t_3 \tag{11}$$

and $$zt' + (x + y)\ t'_2 = t'_3 \tag{12}$$

Equation (12) is based on the fact that for comparatively small temperature ranges, the dew point temperatures may be substituted without appreciable error for the weight of vapor per lb of dry air.

Subtracting (12) from (11): $z = \dfrac{t_3 - t'_3}{t - t'}$

Substituting value of z in (12): $t'_2 = \dfrac{t_3 - zt}{x + y}$

By method of mixtures: $t_1 = \dfrac{xt_o + yt}{x + y}$

and $w_1 = \dfrac{xw_o + yw}{x + y}$

for the weight of vapor per lb air entering washer. The corresponding dew point t'_1 of the air entering washer is thus ascertained. The corresponding wet bulb t''_1 is given by the psychrometric chart and h_1 from the saturated air table. h_2 from saturated air table corresponds to t'_2. Tons of refrigeration required is given by Equation (8).

Selection of Evaporator Cooling Surface

The heat transfer rate of any type of air cooling or heating surface is a function of the velocity of the air through the free area of coils and the temperature of the coil surface. Obviously one must be provided with the unit heat transfer data, as derived by testing, for any particular design of cooling surface and manufacturers of cooling surface supply such information in the form of tables.

The following data apply to a common type of evaporator cooling surface constructed of $\frac{5}{8}$ in. copper tubing wound with a continuous copper fin, 8 fins per in., the coils being placed on $1\frac{7}{16}$ in. centers. Velocity of air through the gross face area of cooling coil enclosure is 400 fpm. These coils are largely employed for direct expansion cooling surface with freon and methyl chloride refrigerants.

No. of tube rows for depth for Cooler $R = \frac{h_1 - h_2}{h_1 - h_X}$	Heat (H) absorbed, Btu per hr per sq ft of face area (A) per deg diff. temp. between refrigerant (t_S) and coil surface (t_X)*
2.....0.544.....	800
3.....0.682.....	1200
4.....0.770.....	1600
5.....0.839.....	2000
6.....0.900.....	2400

*Based on a heat transfer of 26.21 Btu per hr per sq ft of cooling surface per deg diff. of t_X and t_r. 1 sq ft face area = 15.9 sq ft surface per tube row.

h_1 and h_2 = total heat of air entering and leaving cooler, Btu per lb.

h_X = total heat of saturated air corresponding to the temperature (t_X) of the coil surface, Btu per lb.

t_S = temperature of the refrigerant in evaporating coils, F.

A = face area of cooler, sq ft.

$$= \frac{M}{0.075 \times 400} \text{ or } \frac{M}{30} \qquad (13)$$

The relation between the temperature of the coil surface (t_X) and temperature of refrigerant (t_S) is given by the following equation (14):

$$AH\ (t_X - t_S) = (H_S + H_V) + H_L \text{ or } t_S = t_X - \frac{(h_1 - h_2)\ M}{AH}$$

The value of (H) for various tube rows is given by the table.

To prevent the carrying over of free moisture, the face velocity should not exceed 400 fpm.

The method of determining the temperature (t_S) of refrigerant required is, first locate on the psychrometric chart the conditions of the incoming and outgoing air for cooler, knowing the dry and wet bulb temperature in each case. Draw a straight line between these two points extended to intersect the saturation line. The temperature corresponding to this intersection is the temperature of coil surface (t_X) required. Then solve

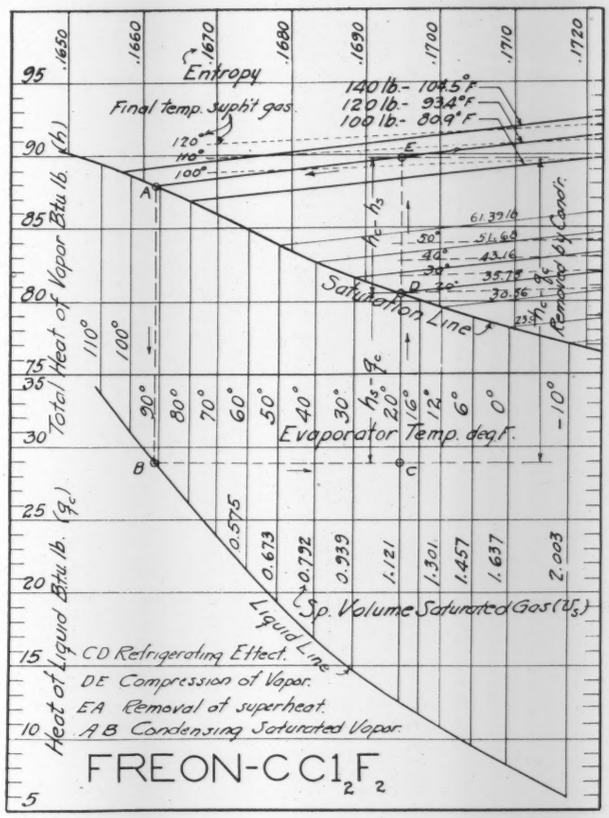


Fig. 4

for the required temperature of refrigerant (t_S) by means of Equation (14).†

Determine number of tube rows required by solving for $R = \frac{t_1 - t_2}{t_1 - t_c}$.

The psychrometric chart (Fig. 2) will, the author believes, be found somewhat easier to read than the usual charts commonly employed in this connection. The freon chart (Fig. 4) was plotted from the properties of this refrigerant given by a table shown in *A.S.R.E.* Circular 12.

Example. Required the face area (A) of evaporative type surface cooler, rows depth of cooler, and temperature of refrigerant (t_S) required for the following conditions. 10 F cooling. Occupancy n = 100 persons. Outside design conditions t_o = 95 F db, 74.6 F wb (38% rh), 66 F dp, w_o = 0.01370 lb.

Inside design conditions, t = 85 F db, 71 F wb, 64 F dp, w = 0.01276 lb.

Assume t_3 = 64.5 F db temperature air entering room. Sensible heat to be removed from the room H_S = 91363 Btu per hr.

Weight of air to be circulated through room and cooler M = 91363/0.24 (85 — 64.5) = 18570 lb per hr or 4127 cfm.

Air required for ventilation, M'_o = 4050 lb per hr.

Infiltration M_o = 11600 lb per hr.

$W_1 = 0.17 \times 100 + 11600\ (0.01370 - 0.01276) = 27.9$ lb per hr.

$W_2 = 4050\ (0.01370 - 0.01276) = 3.81$ lb per hr, $W_1 + W_2 = 31.7$ lb.

†Reference to the psychrometric chart indicates the following relation, $R = \frac{h_1 - h_2}{h_1 - h_X} = \frac{t_1 - t_2}{t_1 - t_X}$. Thus, t_X may be determined for various tube rows or $t_X = t_1 - \frac{t_1 - t_2}{R}$ in which t_1, t_2 are the entering and leaving dry bulb temperatures for cooler.

Air must leave cooler and enter room with vapor content of $w_2 = w_3 = 0.01276 - 27.9/18570 = 0.0112$ lb.

The corresponding dew point = 60.5 F, wet bulb = 61.9 F and $h_2 = 27.5$ Btu per lb.

The dry bulb temperature, air entering cooler is,
$t_1 = 0.22 \times 95 + (1 - 0.22)\ 85 = 87.2$ F.

The air entering cooler carries a weight of moisture, $w_1 = 0.78 \times 0.01276 + 0.22 \times 0.0137 = 0.0129$ lb per lb air. Corresponding dew point = 64.5 F, wet bulb = 71.6 F and $h_1 = 34.8$ Btu per lb.

$$\text{Tons refrigeration} = \frac{18570\ (34.8 - 27.5)}{12000} = 11.3$$

By the approximate method:

$$\text{Tons refrigeration} = \frac{(91363 + 9720) + 1060 \times 31.7}{12000} = 11.2$$

The face area of cooler required with 400 fpm face velocity is,

$$A = \frac{4127}{400} = 10.3 \text{ sq ft}$$

Locate required initial and final conditions of air entering and leaving cooler on psychrometric chart (Fig. 3).

The required temperature of coil surface is, $t_x = 59.5$ F.

$$R = \frac{t_1 - t_2}{t_1 - t_x} = 0.82$$ requires a 5 tube row depth cooler

Solving for temperature of refrigerant, Eq. (14).

$$t_s = 59.5 - \frac{(34.8 - 27.5)\ 18570}{10.3 \times 2000} = 52.9 \text{ F.}$$

Compressor: (Data taken from freon chart).

If freon is employed for the refrigerant with three tube row depth cooler assuming condenser temperature $t_c = 104.5$ F (140 lb abs. pr.) temperature corresponding to condensed gas (liquid) leaving condenser, $q_c = 32.4$ Btu per lb liquid leaving condenser, $t_s = 53$ F, $v_s = 0.71$ specific volume saturated gas entering compressor, $h_s = 84$ Btu per lb saturated suction gas, $h_c = 90$ Btu per lb superheated gas entering condenser.

Weight of refrigerant to be pumped per minute:

$$M_x = \frac{\text{Tons} \times 200}{h_s - q_c}$$

$$M_x = \frac{11.3 \times 200}{84 - 32.4} = 44 \text{ lb or } 3.9 \text{ lb per ton.}$$

Volume of saturated gas to be pumped per minute: $44 \times 0.71 = 31$ cu ft.

The expected compressor displacement is:

$31/0.75 = 41$ cfm (0.75 = volumetric efficiency).

The theoretical horsepower required for compressing the gas is based on the assumption that the suction gas is in a saturated condition at the beginning of compression and that the compression takes place adiabatically (entropy constant).

The *theoretical* compressor power required is:

$$\frac{M_x\ (h_c - h_s)}{42.5} = \frac{44\ (90 - 84)}{42.5} = 6.3$$

The expected brake horsepower required is:

$6.3/0.70 = 9$ (0.70 = overall efficiency).

$(h_c - h_s)$ is the heat equivalent of the work required to compress one pound of gas.

The weight (C) of condensing water required with an initial water temperature of $t_1 = 70$ F,

$$C = \frac{M_x\ (h_c - q_c)}{t_2 - t_1}$$

Assuming a 5 F temperature differential between (t_2), the temperature of leaving water and temperature of condensed liquid (t_c),

$t_2 = 104.5 - 5 = 99.5$ $\quad C = \dfrac{44\ (90 - 32.4)}{99.5 - 70} = 86$ lb per minute, or $\dfrac{86 \times 60}{8.33} = 620$ gallons per hr.

[This is the first of a series on air conditioning by Mr. Harding.—EDITOR.].

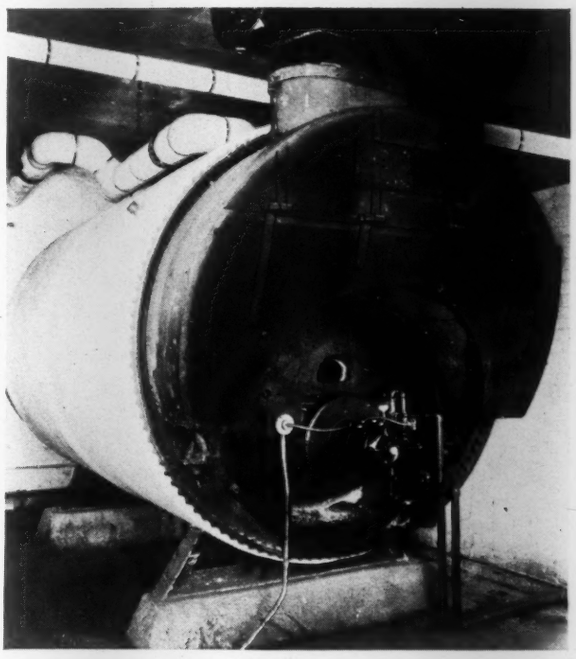
Creep of Materials at High Temperatures

IN GENERAL, the application of material at high temperatures resolves into two principal classes, differing with respect to the manner of stress application: (1) constant stress; (2) variable stress (relaxation).

The case of constant stress is fairly close to circumstances of long time creep tests itself. It is principally a matter of extrapolating the test results through long periods of time. At the present time, we have no other method but to assure that creep continues at the smallest rate recorded by the available test. The principal problem, then, is to obtain reliable values of the minimum strain rates as functions of stress and temperature for each material.

The most important cases of creep, under constant or nearly constant stresses, are rotating structures under centrifugal forces and pressure vessels under internal pressures. In both of these cases, conditions may be more or less complicated by variations of stress over the section, and changes in stress, due to plastic flow and so on.

The case of relaxation is somewhat further removed from the conditions of the test, and a more elaborate method of interpretation is necessary. The principal source of information is still the long-time creep test. In this case, the plastic deformation of the material causes a marked reduction in stresses, so that the limits are set by reduction of the stress, rather than by changes of the dimensions. The typical example of this case is the bolt problem, such as the horizontal bolting of a turbine cylinder, or the flange bolting of a pipe joint. In these cases, the structure is initially assembled with certain stress which will drop with time at a reducing rate. The order of magnitude of the time involved depends on the material, the elasticity of the structure, and the initial stress. In addition, the time for a certain reduction of the assembly stress increases slightly for each successive re-tightening of the structure. —From a paper presented before the *Technical Association of the Pulp and Paper Industry* by W. P. Manning, Turbine Engrg. Div., Westinghouse Elec. & Mfg. Co.



At right—The 125 hp scotch marine oil fired boiler which supplies steam for heating the oil in the tanks and for heating the plant offices

Design and Erection of a Bulk Fuel Oil Storage Plant†

Kalman Steiner*

ECONOMY in handling fuel oil and gasoline in a bulk storage plant depends upon proper layout of the various components of the plant, the interconnecting piping, and the pumping equipment. Two previous articles[1] have discussed the selection of the site, determination of required storage capacity, structural considerations, plant layout, tank design, design of the piping, and pumping equipment, using as an example a recently completed plant of this kind. The present article, which concludes this series, covers the estimation of the required boiler capacity for heating the oil and the plant offices, sizing steam and return piping, and heating the offices; the question of converting the steam plant to high pressure for future generation of electric power required for pumping the oil is also considered.

Estimating Required Boiler Capacity

The boiler capacity for the heating load can easily be over-estimated if a logical check is not used. For instance, if it were assumed that the boiler must be large enough to carry all 17 coils at their peak possible load condition, which would occur if the contents of all tanks were simultaneously under a pumping operation during a severe cold wave, the consumption would be based upon a 50 Btu transmission rate. By taking 265 sq ft multiplied by 17 (the number of such coils) and the 129 F average temperature difference, we would find that our coils would be capable of transmitting the astonishing total of 29,057,250 Btu per hr. This latter figure, at 33,500 Btu per boiler hp, is equivalent to 855 boiler hp, and of course is far in excess of the actual boiler capacity required.

A sensible check against this is to take the plant's maximum probable daily output on a peak day. It happens that in the retail fuel oil business, an output from a single plant of 100,000 gallons per day is considered excellent business, and in fact 80 per cent of that is commonly the top gallonage attained in such plants. Now if it were necessary to take in 100,000 gallons from railroad cars at sub-zero temperatures, and ship this quantity out at 150 F, then the boiler load, on a uniform 24 hr basis, would be 66 boiler hp.

It is a matter of experience that a 50 hp boiler would carry this load. In the plant under consideration, the boiler actually used is a 125 hp scotch marine, fired with a 200 boiler hp horizontal rotary oil burner. With the overload which a boiler of this type is capable of carrying, this was considered to be ample steam generating equipment for the present and future needs of this plant, even though its capacity be doubled by future additions of storage tanks and accompanying equipment. It may be of interest to state that during the winter of 1934-35, during periods of sub-zero weather, this boiler and oil burner were not called upon to carry heavier loads than the equivalent of 30 gallons of fuel per hour, or roughly 90 boiler hp, and even at such times the load was obviously unnecessarily great, for the storage tanks were being carried at temperatures much higher than actually needed.

*Chief Engineer, Consumers Petroleum Co., Chicago, Ill.

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[1]See pp. 241-244, H. P. & A. C., May, 1935, and pp. 282-284, June, 1935, H. P. & A. C.

Sizing Steam and Return Piping

The computation of the sizes of steam and return piping need not be given in detail, as standard tables of the *A.S.H.V.E.* and other authorities make this a relatively simple problem. The amount of steam passing through the pipes, which is the data needed for using such standard tables, must, however, be based upon the *probable maximum oil pumped,* rather than on the condensing ability of the heating coils. In this plant, the steam main, leaving an 8 in. boiler header, runs as a 6 in. line for its entire length, and terminates in the pump house. Future extensions of this main for additional tanks can easily be made, for it is sufficiently large for double its present load. From this main, all connections to the coils in tanks—and each coil has its own direct connection to the main—are 3 in., and each coil of course has its own gate valve for regulation or complete shut off.

Perhaps the most unique feature of this entire steam piping system is the fact that each of the 17 tank coils has a steam trap on the condensate outlet, and these traps are all outdoors, with no insulation or protection from winter weather. Of course both the steam piping and return lines are heavily insulated. Condensate leaves the tanks at at least 150 F, and after passing through the exposed trap, immediately enters the covered return. Hence the traps are always at a temperature well above the freezing point. Should one of the coils be taken out of service, a drain valve on the trap is opened to remove all water. Should the boiler be down for any considerable length of time, the drain valves on all the traps are opened.

Heating Plant Offices

The office building heating plant is a separate unit, consisting of a small steel boiler, a domestic type oil burner operating from electric ignition, five unit heaters serving the five offices, and a system of electric controls which synchronize operation throughout. Each office has its own thermostat, which will directly start and stop the unit heater in that office, provided steam is available. Should there be no pressure on the boiler at that instant, then the thermostat will also start the burner; meanwhile the unit heater does not start. As soon as 1 lb steam pressure has been built up, the unit heater can start, as well as any others that have meanwhile been called for by their respective thermostats. As soon as all the unit heaters have been stopped, (*i. e.* all five thermostats satisfied), the burner also stops. The cycle is then repeated many times during the day. At night, and over Sunday, a master thermostat controls the building temperature at 60 F, stopping the oil burner when that temperature is attained. Since the unit heaters cannot run when steam pressure is down, their own thermostats do not control them over night. Other controls used are a low-water cut-out, and a boiler water feeder. This heating plant is so completely automatic that no one at the plant pays the least attention to it. The result is that the fuel oil storage tank usually runs dry before someone, noticing the dropping temperature in the building, puts in a frantic call to the plant superintendent, who has some 600,000 gallons of the stuff about 50 yards away.

Piping Welded

With the single exception of the valve flanges and pump flanges, all pipe lines and bends and connections are welded. Acetylene torches were used for this work. Upon completion, the steam lines were tested at 150 lb pressure and the oil lines at 75. Let it be said here to the credit of the contractor and his men that the leaks proved up by the tests were trivial; in fact the only one of consequence was a split seam in a section of pipe—a defect of the mill.

Generate Electric Power in Future?

There is one additional reason this plant has been laid out with a high pressure steam system—or at least convertible to high pressure if and when desired. That is the possibility of generating electric power. The existing steam requirements are so large that the heating will easily absorb the low pressure exhaust from a steam engine or turbine. In fact, the total electric power requirements of this plant could be provided with an amount of steam supplied to a generating unit equivalent to only ⅓ that actually taken by the heating coils. Thus, if this steam were developed at about 100 lb pressure, and then put through a steam engine or turbine as exhaust it would have to be augmented by an addition of twice as much in order to heat the oil in storage. It is not a remote possibility that such a generating plant will be installed.

In these pages an attempt has been made to present in a logical manner the technique of designing and erecting a bulk plant. Some assumptions have been made, based upon known practice, but most of the underlying theory has been stated. There may—in fact probably, will—be other engineers who can take exception to parts of this discussion. No pretense is made that what is herein presented is the best; but at least there have been sound reasons for the procedure adopted, and certainly results have not been disappointing. Such assumptions as have been made were however based upon long and intimate experience in the operation of such plants, and if these statements appear to be in conflict with or to deviate from accepted practices, it is only because personal experience has proved out the facts and justified the procedure.

(The contractor for the heating and piping was the Advance Heating Co., Chicago, and the tanks were erected by Chicago Steel Tank Co.)

Design of Modern Industrial Piping Systems — Flexibility of Piping

The title of the fifth column of Tables 4 to 12 of this article published on pp. 181-186 in the April, 1935, HEATING, PIPING AND AIR CONDITIONING is given as $1.5D^{1.66}$. This should read $(1.5D)^{1.66}$.

By **D. W. Burnett***

Insulation Blown in Hollow Mullions and Spandrels of New Post Office Building

In the St. Paul post office and custom house, the continuous window mullions and spandrels are hollow and the radiator risers and take-offs run within them. The mullions and spandrels were blown full of rock wool insulation to insulate the piping and to make the entire construction about the windows and over the spandrel areas non-conductive

THE application of insulation in the U. S. post office and custom house at St. Paul, Minn., completed last year, is worthy of notice, as it is believed this is the first time the pneumatic method of installing insulation was used for locating insulation in hollow mullions and spandrels of a new structure. This application of insulating material parallels the extending use of metal in the exterior treatment of buildings of all kinds.

One feature in particular indicated the advantage of this method of insulation: Heating riser pipes were enclosed in some of the interior mullions, and the space around these pipes was so small as to prohibit the use of pipe covering. By using rock wool insulation blown in place, it was possible to fill the entire mullion space around the pipes. The sections of mullions and spandrels in the accompanying figures show the construction and location of the insulation. Note that the pipe riser in the interior mullion is completely embedded in the rock wool insulation. Note also that access to the hollow space in the spandrels was gained through a small opening in the masonry behind each spandrel section which was closed after the insulation was blown in.

The pneumatic conveyor used for installing the insulation is standard equipment and consists of a gasoline engine power plant with built-in clutch, speed reducer, feeding device and blower, all mounted on a frame. The feeder is surmounted by a hopper into which the rock wool is charged, thence to be blown through a rubber hose to the point of application. Operating pressure is about 3 lb per sq in. at the blower. All blowing was done from the 4th and the 7th floors, the three stories below being blown from each location and the 7th story to the roof also blown from set-ups on the 7th floor. The blowing machine was mounted on a dolly to facilitate moving about on each floor. About 48 tons of rock wool were used, and approximately 57 days were required to complete the installation. Work was done intermittently as erection of the building progressed.

*Engineering Dept., General Insulating & Mfg. Co., Alexandria, Ind.

Fuel Saving Estimated

While the construction over insulated areas varies somewhat throughout various parts of the building, so that a variation of insulation thickness and a variation of other materials and their thicknesses obtains, it is possible, through a careful analysis of the construction to arrive at a fairly close approximation of the yearly saving in heat which the insulation produces.

Over some areas, the insulation thickness is but 2 in.; over others, it is 6 in. In various places the insulation is backed by 6 in. of tile, 9 or 12 in. of brick, by thick reinforced concrete beams and columns, etc. A study of the entire construction however, taking into account the extent of each particular detail of construction, has led to the selection of an average construction which is taken as a basis upon which a reasonably close determination of the overall heat losses can be made. From inside to outside, this construction comprises: lath and plaster, 6 in. brick, 4 in. air space which is filled with rock wool, and metal exterior panel. It is further

The insulation blowing equipment in operation. Note opening in side of interior mullion for insertion of blow nozzle

estimated that all areas insulated over the entire building would be equivalent to approximately 42,000 sq ft of this average construction.

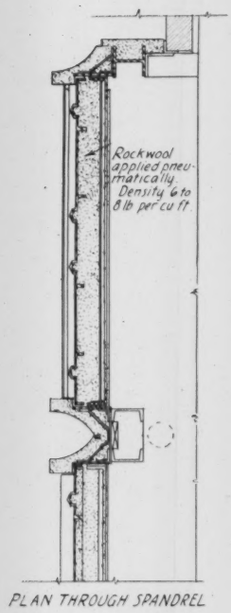
Calculating the transmittances of the above construction both uninsulated and insulated; neglecting the metal:

$$U_1 \text{ (uninsulated)} = \frac{1}{\frac{1}{1.65}+\frac{0.75}{3.3}+\frac{6}{5.00}+\frac{1}{1.1}+\frac{1}{6.00}} = 0.321$$

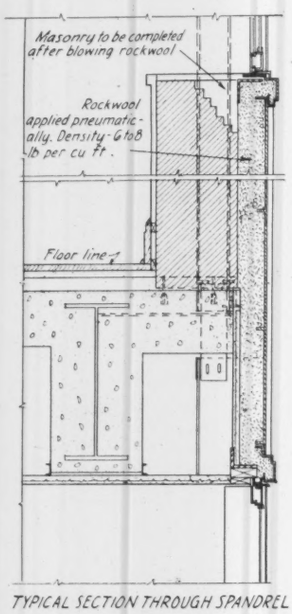
$$U_2 \text{ (insulated)} = \frac{1}{\frac{1}{1.65}+\frac{0.75}{3.3}+\frac{6}{5.00}+\frac{4}{0.30}+\frac{1}{6.00}} = 0.064$$

Subtracting U_2 from U_1 it is seen that the heat saving amounts to 0.257 Btu per hr per sq ft per F temperature difference. This saving can be converted into pounds of coal saved in operating a hot water heating system by means of the formula:

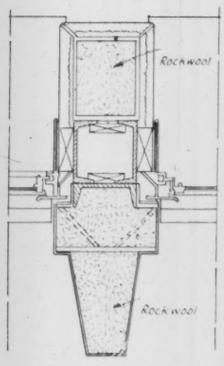
$$F = \frac{(U_1 - U_2) \times N \times (t - t_a) \times A}{C \times E \times 2000}$$



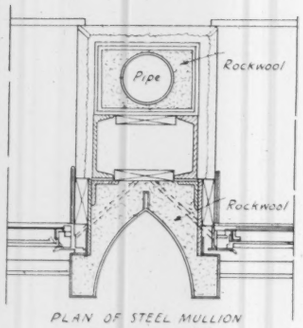
PLAN THROUGH SPANDREL



TYPICAL SECTION THROUGH SPANDREL



PLAN OF WINDOW



PLAN OF STEEL MULLION

F = saving in tons of coal per heating season.
U_1 = thermal transmittance of uninsulated areas = 0.321.
U_2 = thermal transmittance of insulated areas = 0.064.
N = number of hours during heating season = 3780.
t = inside temperature = 70 F.
t_a = average outside temperature during heating season = 30 F.
A = area = 42,000 sq ft.
C = calorific value of coal = 13,000 Btu per lb.
E = overall efficiency of heating system = 70 per cent.

$$\text{Solving: } F = \frac{0.257 \times 3780 \times 40 \times 42{,}000}{13{,}000 \times 0.70 \times 2000} = 90 \text{ tons}$$

Considering the long period of time which the insulation will remain in service in this building it is evident that the low charges for depreciation will result in a low cost per year for the insulation, which in turn, results in larger net savings through reduced fuel requirements. Added to this is the saving made in radiation requirements which can be taken advantage of in new construction.

Refrigerated Flies

ALTHOUGH our own record in converting wastes and nuisances to profit is one upon which we pride ourselves, we gladly take off our hats to an industrial engineering friend of ours for a superlative achievement in this field which has just come to our notice.

A client of his raised mushrooms and fertilized his beds with manure. This practice resulted in the hatching out of vast numbers of flies which were extremely difficult to get rid of.

The engineer recommended the installation of a suction fan which passed both air and flies over some refrigerating coils in such manner as to chill the flies and then drop them in a dormant state into large milk cans. The installation was made and the flies eliminated as a nuisance.

The canned flies are now shipped to frog raisers. Upon receipt the cans are immersed in a brine solution, which chills the flies and again renders them dormant. In that condition they are fed to the frogs.

The mushroom grower now realizes from the sale of flies nearly as much as from the sale of mushrooms.

The only accomplishment which may seem worthy to rank with this and known to us was that of Professor Elihu Thomson in luring millions of male mosquitoes from the Lynn marshes to their destruction on the walls of an electric furnace by causing the furnace to emit a hum identical in pitch with that of the female mosquito.—"Industrial Bulletin" of Arthur D. Little, Inc.

Valuable Byproducts from Waste

. . . Piping and Drying Equipment for Reclaiming Whiskey Still Waste

By **Warren Viessman***

THE competition of today has made it necessary to find, develop, and market new products from materials formerly wasted. The distillation industry is paying much attention to byproduct utilization at the present time. In a rye whiskey distillery, for instance, the carbon dioxide given off from the fermenters is usually wasted but can now be salvaged, as is done at the Hiram Walker plant, and disposed of as tank gas or dry ice. The discharge from the still is valuable for cattle feed; it can be disposed of as bagged distiller's grains, and as liquid slop rich in proteins, for cattle feed. This paper, which was presented at a recent meeting of the *American Chemical Society* in New York, describes such a plant, including the drying of the material and the piping for the slop, which has a low pH value.

The material from the still contains approximately 5 per cent solids and 95 per cent liquids, of which lactic acid is a constituent, the acidity being about 4 per cent and the pH value being 3.8 as determined by the color partition method. This material usually goes to large cypress vats, open to the atmosphere so that the hot vapor can readily escape. The vats must be agitated either mechanically or by air in order to prevent the solid matter from settling out; the former method has been found superior, unless relatively high air pressure is used, as the jets tend to clog.

*Formerly, Chief Engineer, Baltimore Pure Rye Distilling Company, Dundalk, Md.; now Associate Mechanical Engineer, Procurement Division, U. S. Treasury Dept., Washington, D. C.

From the vats the slop is pumped through bronze piping to the strainer reels in the dryer house by a bronze centrifugal pump. An earlier installation utilized galvanized steel pipe, malleable iron galvanized fittings, and black cast iron valves with brass trimmings, but the piping had to be replaced within three months due to metal dissolving away and causing failure at the threaded joints. After one year of service the standard bronze pipe, fittings and valves (containing 85 per cent copper), are in excellent condition.

Separation of Liquid from Grain

First step in separation of the liquid from the grain in the mixture takes place by dehydration in passing the mixture over the screens where a part of the free surface moisture is removed by an indirect pressure method. Average temperature of the slop to the screens or strainer reels, is about 87.8 C, (190 F). The reels consist of one or more rotary inclined screens which strain off the larger solids from the liquid. When two screens are employed they usually consist of 50 and 80 mesh bronze wire cloth; this however is a function of the fineness of grinding the grain. The strained thick slop discharged from the first screen averages 12 per cent solids and 88 per cent liquid and the thin slop contains a small percentage of suspended solids which are reclaimed by passing through the second rotary screen with a finer mesh. The liquid discharged from

Described here is a method of converting waste from a whiskey still into valuable byproducts, the conversion also solving a problem in sanitation and public health. By this process, still slop is separated into a liquid which can be disposed of in several ways, one of which is a liquid cattle feed, as it is rich in proteins, and as dried distiller's grains which are bagged and shipped to a wide market . . . Consideration is also given to the piping for the slop which has a low pH value, the steam piping, pumping equipment, steam and power requirements, and the results obtained.

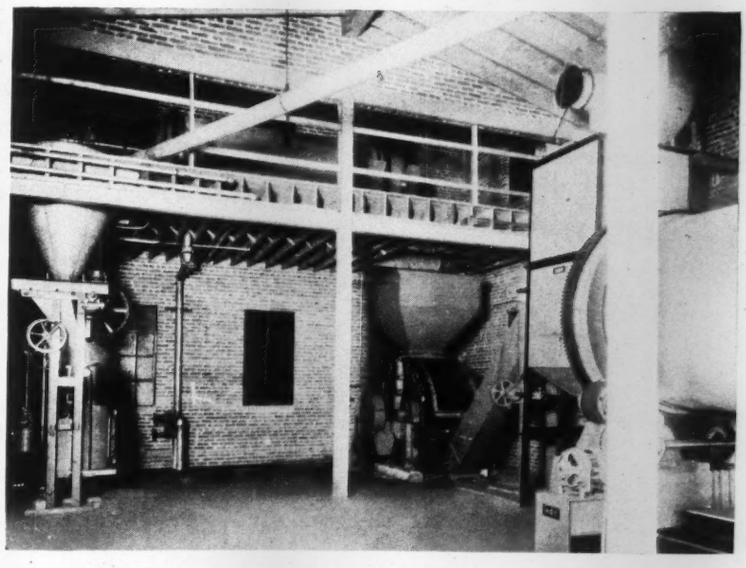


Fig. 1—Arrangement of plant, showing strainer, press, bagger and part of the dryer

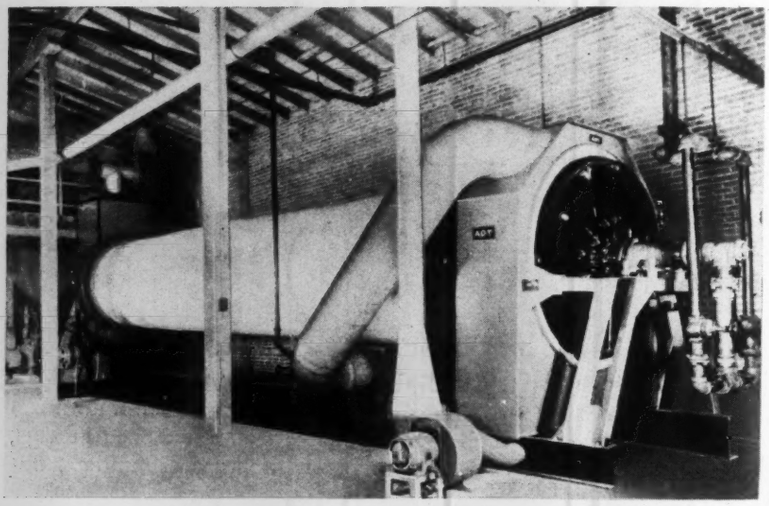
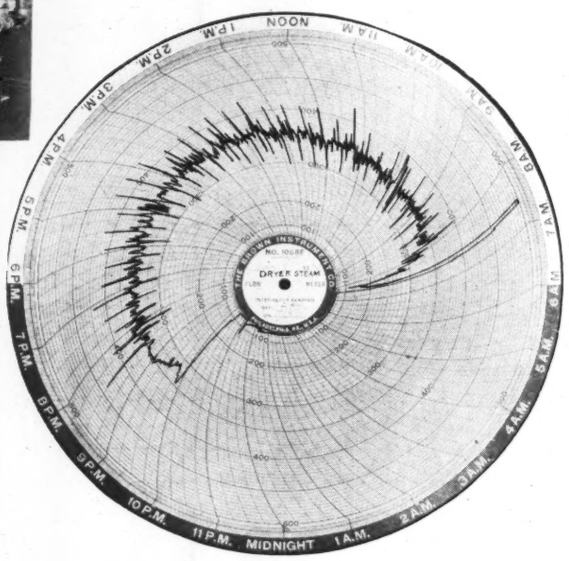


Fig. 2—The rotary dryer

Fig. 3—Nature of the dryer steam load



the second screen contains practically no material in suspension, and is discharged to the sewer, to a vat for tank truck disposal, or to evaporators and auxiliary equipment as conditions require. The strained material discharged from the screen averages 10 per cent solids or 90 per cent moisture. In passing through the rotary screens its temperature is reduced approximately 5.5 C (10 F). Hot water, cold water, and steam sprays have been used to clean the screens while in service, but a high pressure steam hose has been found most effective.

Second step in the separation takes place by dehydration in passing the grain discharge from the screens through a rotary filter press, which removes another increment of free surface and capillary moisture by a direct pressure method which compresses the material. All the heavy strained material from the primary and secondary screens is discharged into a reserve hopper placed above the rotary filter press which it feeds. In passing through this press, the moisture content is reduced to between 70 and 75 per cent. Pressure of about 25 lb per sq in., usually taken from the cold water supply through a pressure regulator, is applied to the rollers of this press, so that constant pressure is obtained on the material. The liquid pressed from the grain and discharged through the filter plates of the press is returned by a small centrifugal pump to the secondary rotary screen so as to reclaim any solids that may have passed through. The temperature of the material is reduced approximately 5 per cent when passing through the press and is delivered to the dryer at 79.4 C (175 F).

The third and last step takes place by thermal drying of the grain received from the press in passing through a dryer where the surface and capillary moisture is removed by contact drying with steam coils and by indirect drying through the supply of heated air which carries away the vaporized moisture.

Drying the Pressed Material

Speed of the press is adjusted to deliver a constant flow of material to the dryer and is used as an automatic feed for that machine. The pressed material is fed to the dryer by a drag type elevator which discharges to a screw conveyor contained in the feed chamber placed at the feed end of the rotary clyinder. This chamber also acts as an expansion chamber for reducing the velocity of the vapor-charged air coming from the dryer cylinder, thus allowing the material carried out with the air to settle and be returned again with the wet pressed material to the cylinder. The vapor-charged air is exhausted from the dryer cylinder by a fan which discharges into a special insulated dust collector to prevent any loss of fine dust that may be carried along with the vapor-charged air. The dust collector discharges the fine dust into the stream of wet pressed material so that it is automatically returned to the dryer cylinder. Any condensation which may occur in the exhaust pipes and dust collector is trapped at the discharge spout from the collector and does not return to the dryer. The vapor-laden air exhausted through the fan has average wet and dry bulb temperatures of 58.9 and 60.4 C respectively (138 and 141 F).

The rotary cylinder of the dryer is provided with steam coils, and special elevating shovels attached at intervals to these coils for elevating and dropping the material in the air stream and distributing the material over the heating tubes. The rotary cylinder is on an incline of approximately ½ in. per ft; speed is 4 rpm. The material or dried grains is discharged from the dryer in a constant stream when properly fed, and with a moisture content of less than 10 per cent.

The air forced through the dryer by the fan is first preheated by a steam coil under the dryer cylinder. The temperature of the air leaving the preheater and entering the dryer is about 85 C (185 F).

Packing the Dried Grain

The dried grain discharged from the dryer is passed through an exhaust fan which elevates it to a dust collector above the bag packer. This packer presses the dried grain compactly in smaller sacks than is possible with the ordinary bag filling apparatus by means of a screw propeller and a weight loaded trip. By using the pneumatic system for conveying the dried grain from the dryer to the bag packer, the temperature of the material is reduced and the dried grain is sacked with a temperature seldom exceeding 37.8 C (100 F). The flexibility of the pneumatic system also makes it preferable to other methods of transport.

Average Results Obtained

When handling straight rye mash which contains not more than 2½ per cent barley malt, the following average results have been obtained per hr from a plant grinding 1000 bushels of grain in 8 hr:

Wet pressed material to the dryer, 75 per cent moisture....3600 lb
Dried material from dryer, 10 per cent moisture.....1000 lb

Evaporation of dryer.....2600 lb
Heat to dryer.....3,134,000 Btu per hr
Overall coefficient of heat transfer.....
.....15 Btu per sq ft per hr per F temp. diff.
Heat to air preheater.....506,000 Btu per hr
Overall coefficient of heat transfer.....
.....34 Btu per sq ft per hr per F temp. diff.
Total steam to dryer and air preheater (115 lb pressure).....
.....3620 lb per hr
Weight of steam per unit weight of product.....3.62 lb per lb
Material to press from rotary strainers,
88 per cent moisture.....10600 lb
Material from press, 75 per cent moisture 3600 lb

Water removed by press..... 7000 lb or approx. 14 gpm
Slop to rotary strainers, 95 per cent
moisture .....46900 lb
Material discharged from rotary strainers,
88 per cent moisture.....10600 lb

Water removed by rotary strainers.....36300 lb or approx. 73 gpm

The pump which handles the thin slop from the reserve tanks to the rotary strainers has a capacity of 125 gpm and is throttled to conform to the desired capacity of the complete plant.

The high pressure steam, which first passes through the coils of the dryer cylinder, then into the coils of the air preheater, and then to the steam trap and return line, is controlled by throttle valve at the dryer cylinder.

The yield in dried grains per bushel of grain ground varies with the fineness of grinding, the method of mashing, the percentage of barley malt used with the rye, and with the condition and method of operation of the equipment. For instance, from straight rye there can be recovered 12½ per cent of the material ground whereas with barley malt the recovery is 35 per cent. The yield from a grind of straight rye using 2½ per cent barley malt would be approximately 7.5 lb per bushel whereas with 12½ per cent barley malt the yield would be increased to 10.5 lb per bushel.

When handling the slop from a corn mash the yield is materially increased; for instance, a corn mash consisting of 80 per cent corn and 20 per cent barley malt would give a yield of approximately 12.5 lb per bushel, and a mash consisting of 55 per cent corn, 35 per cent rye, and 10 per cent barley malt would give a yield of approximately 10.5 lb per bushel. This increase in capacity is obtained by reducing the moisture content in the material discharged from the press, which runs as follows: rye, 68 to 75 per cent; corn, 60 to 68 per cent. It is readily observed that the yield per bushel can be accurately estimated only when all conditions surrounding the manufacture of the basic product are known.

Steam Consumption and Power Requirements

The steam consumption per pound of dried material also varies with the kind of product handled, and is dependent to a large extent on the moisture content and temperature of the material as fed to the dryer. With a corn mash containing 60 to 65 per cent moisture fed to the dryer, the steam consumption per pound of dried material will range from 2 to 2.75 lb, whereas with rye mash containing 70 to 75 per cent moisture fed to the dryer, the steam consumption per pound of dried material will range from 3 to 4.5 lb per lb of product, depending largely upon quality and continuity of operation. The chart shows the nature of the steam load.

The power load for operating the dryer plant of the 1000 bushel distillery, performance data of which is presented above, was ascertained by test to be as follows:

Unit	Installation, Hp	Load, Hp
Centrifugal pump	2	1.6
Rotary strainers	2	1.2
Hydraulic roller press	5	2.5
Dryer	5	4.3
Exhaust fan	5	4.3
Dry grains fan	2	1.7
Bag packer	5	5.0 (intermittent)
	26	20.6

Electric motors were used for all of the above drives. The units of the installation are so arranged that only one operator, who also bags the material, sews the bags, and stores them, is required.

The steam pressure delivered to the dryer through the 4 in. main ranges between 115 and 125 lb per sq in. The condensate from the dryer and air preheater is returned directly to the boiler room hot well through a high pressure bucket trap. The condensate return line is 2 in.

Specifications for major items for the above size plant are:

Rotary Strainers

Cylinder diameter.....48″
Cylinder length.....15′-0″
Screen sections.....4
Total screening surface.....144 sq ft
Speed of cylinder.....12 rpm
Direct geared motor.....2 hp
Weight .....5500 lb
Slop delivered to strainers.....100-125 gpm
Thin liquid slop from strainers.....70-75 gpm

Hydraulic Roller Filter Press

Filtering drum diameter.....48″
Width of filtering channel.....24″
Number of pressure rollers.....5
Hydraulic cylinders.....2
Speed of filtering drum.....1 rpm
Direct geared motor.....5 hp
Weight .....10000 lb
Thin slop returned to strainers by pump.....10-15 gpm

Rotary Dryer

Diameter of cylinder.....72″
Length of cylinder.....30′
Number of heating tubes.....160
Diameter of tubes.....1⅝″
Number of coils.....20
Number of pipes in each coil.....8
Heating surface .....2100 sq ft
Number of bearing rollers.....8
Width of bearing rollers.....8″
Steam inlet to coils.....4″
Exhaust from coils.....2½″
Direct geared motor.....5 hp
Weight .....58000 lb

The cylinder is insulated with 1 in. hair felt and canvas covering. The dryer is provided with a motor driven vapor exhaust fan discharging into a special type of dust collector, and is equipped with an air preheater for preheating the air before it is passed through the dryer.

Air Preheater	
Air capacity	4800 cfm
Fan motor	5 hp
Steam coil pipe size	2½"
Length of coil	282 ft
Heating surface	213 sq ft

The rye distillers grains are sold under the following guaranteed analysis:

Crude protein, not less than	17 per cent
Crude fat, not less than	5 per cent
Crude fiber, not more than	20 per cent
Carbohydrates,	
Nitrogen free extract, not less than	40 per cent

Liquid Slop Piped to Vat

The strained liquid slop from the screens is pumped to a cypress vat for tank truck loading, to be used as cattle feed, as it is still rich in protein content. The surplus goes to a private sewer constructed of 6 in. transite pipe, made of asbestos and cement, with a special interior coating. This pipe line is about one mile long, and is laid in the ground. The pipe joints are made up with leadite. Expansion due to heat is cared for by copper expansion joints.

This piping system is non-corrosive and not subject to tuberculation. The value of c in the Hazen and Williams formula has been determined to be over 140 for this pipe.

In the plant described the recovery of byproducts is of two-fold interest. Apart from the remuneration involved and a reduction in overhead obtained by the sale of the liquid slop and dried material, the disposal of the spent grains mixture by this method relieves what would be an acute sanitary problem. The plant is in a semi-residential and industrial section, which necessitates a private sewer to a creek entering the harbor which must not be subject to serious pollution. The removal of the spent grain, and the reduction in the volume of the liquid to the sewer is therefore important from the viewpoint of sanitation and public health as well as from economic considerations.

H. P. & A. C. Inspection Trips --- Installing Heating System

Fig. 1—Ten inch steam line being fabricated on the job, Mellon Institute for Industrial Research, Pittsburgh. The fitting has been welded to the main line and the welder is tack-welding the branch to it.

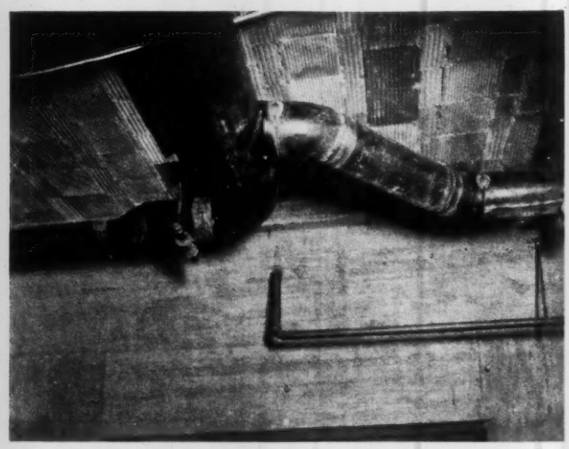


Fig. 2—The fabricated unit in place. The manner in which the fitting is welded directly to the 45 deg elbow is clearly shown.

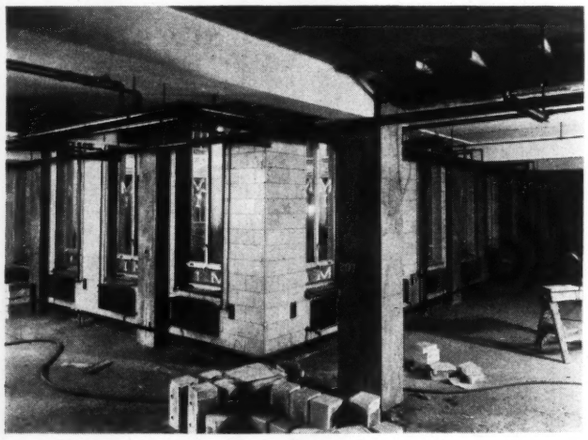


Fig. 3—General view of the radiator connections, and in the upper background some of the many branches.

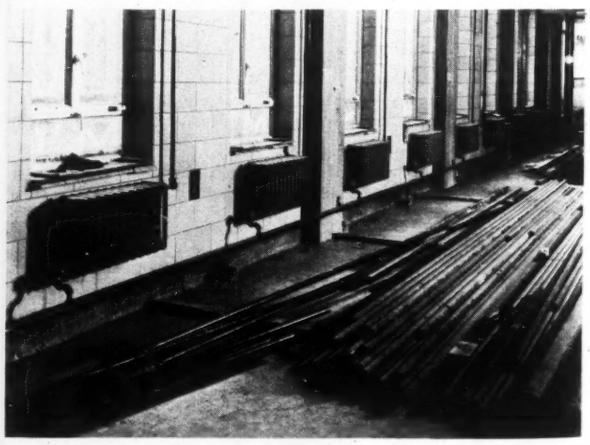
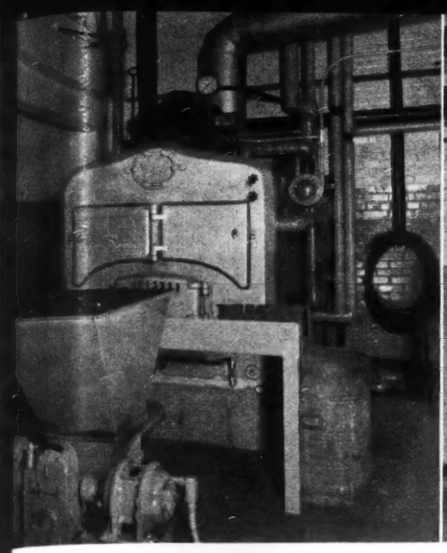
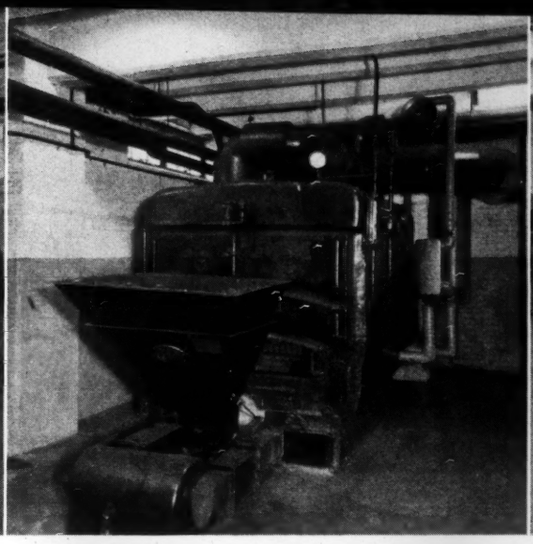


Fig. 4—Close-up of the radiator connections. All of these connections are made to the main pipe by means of fittings welded in place to the latter and provided with threads at the other end for the radiator connections, making it possible for the contractor to use random lengths of pipe and eliminate cutting.—Francis A. Westbrook.





Operating Time and Trouble Saved

. . . . *if attention to coal and ash handling, accessibility for repairs and operation, is given to stoker installations*

By **Sabin Crocker***

ASIDE from the questions of adequate size and satisfactory combustion characteristics, thought must be given to installing stokers for convenience in coal and ash handling and accessibility for operation or repairs. This article discusses these phases of installing single-retort underfeed stokers in medium size heating boilers.

One of the principal advantages of stoker firing over hand firing is the reduction in attendance required, thus releasing the boiler operator in many cases for other part-time duties. With this in view attention to details which contribute toward reducing the time and labor required for firing are worthwhile provided the cost is not excessive. In many cases the only added cost is a little ingenuity, while in others a reasonable expenditure for coal and ash handling equipment plus ingenuity is as well justified as is the purchase of the stoker itself.

A prime factor affecting the arrangements for tending a stoker concerns the necessity for having adequate furnace height and governs how the stoker should be set with respect to the boiler room floor level. Three combinations of conditions are commonly encountered.

1—Stoker and boiler base both at floor level.
2—Stoker in pit, boiler base at floor level.
3—Stoker at floor level, boiler base elevated.

While medium-size cast iron boilers and compact welded steel boilers usually are built with their crown sheets at a height of only 2 to 3 ft above the grate level, this distance is insufficient for best results with stoker firing. Consequently when applying stokers to such boilers it is desirable to adopt alternative (2) or (3) above in order to increase the height of the combustion chamber. The design of coal and ash handling arrangements and other operating features should then be arranged best to suit the boiler-stoker combination.

*Engineer, The Detroit Edison Co., Detroit, Mich. Member of Board of Consulting and Contributing Editors.

Stoker and Boiler Base at Floor Level

Where the boiler already has sufficient height in the combustion chamber, or where it is impracticable either to raise the boiler or to pit the stoker, the stoker and boiler base both will be at floor level. This simplifies the design in several ways since the operating parts of both boiler and stoker are readily accessible and there is ample clearance for working the fuel bed with firing tools and for removing ashes. The principal inconvenience in this arrangement over a pitted job is the greater height to which coal must be raised in filling the hopper.

Fig. 1 (left)—Stoker and boiler base both at floor level; ashes removed through firing door. Fig. 2 (center)—Stoker and boiler base both at floor level; double side ash dump. Fig. 3 (right)—Stoker in pit, boiler base at floor level.

A simple form of this type of installation in a 36 in. boiler is shown in Fig. 1. The hopper is filled with a large scoop shovel from the coal bin (not shown) which is situated at a convenient distance behind the stoker. If the bin were farther removed, coal could be brought over in a wheelbarrow and re-shovelled into the hopper. An ash can hoist is located in one corner of the boiler room, to which the cans shown in the picture can be skidded for elevating to grade level where they can be dumped directly from the hoist into a motor truck.

Since this particular stoker has no dump plate the ashes are removed by hoeing them into a heap on top of the retort where they are fused together into a clinker and removed through the door intended for hand firing. A feature added for convenience in this operation is the apron pan shown between the hopper and boiler, onto which the clinkers can be forked for skidding into the ash can shown at the right of the apron.

This pan reduces the dirt nuisance incidental to ash removal and facilitates the transfer of debris from furnace to can.

Fig. 2 shows a somewhat similar installation in a 48 in. cast iron boiler, but made with a double-side-dump stoker. The extension shown on the top of the hopper was removed later to avoid lifting the coal shovel so high in filling the hopper, although at the expense of a considerable decrease in storage capacity. Hoppers in general should be proportioned to give at least a liberal overnight's coal supply, being built with respect to the fuel requirements of the job rather than kept to a standard size. Extensions usually can be easily attached to increase the capacity where required.

Figs. 1 and 2 illustrate about the simplest type of installation which is reasonably convenient to operate. Somewhat more elaborate stoker installations with coal and ash handling features to match are discussed below in connection with the other types of settings.

Stoker in Pit, Boiler Base at Floor Level

The pitted stoker, Fig. 3, is part of a larger and more elaborate installation in a 54 in. boiler designed to handle an ultimate load of about 15,000 sq ft of (240 Btu) radiation. The floor of the pit has been depressed sufficiently to give the desired furnace height and the plan proportions made ample for access clearance all around the stoker. At the extreme right of the pit is shown an alcove where an ash can is set for filling when cleaning the fire. This stoker has a single dump plate on the right hand side of the boiler onto which the ashes are hoed in cleaning the fire, and from which they are dumped into the ash pit, wet down with a spray pipe, and shovelled into a can placed in the alcove. A removable guard rail is provided around the pit and stairs for safety.

A monorail with hand operated travelling hoist conveys coal and ash buckets to and from the stoker. The monorail (upper foreground of the picture) has a switch for directing the travelling buggy toward either the coal bin or the ash hoist. A tilting bucket is used for coal transport from the bin, where it is filled with a hand shovel, to the hopper, where it is emptied by dumping. With some pitted stokers where the top of the hopper comes at a proper height with respect to floor level, it may be convenient to fill the hopper with a wheelbarrow, using a plank ramp if necessary to approach the hopper in a way that permits the wheelbarrow to be tipped into it.

Due to the size of this job and the depth of the boiler room below grade, it was deemed advisable to use a "side-walk elevator" type of ash hoist here rather than the simple hoist employed in connection with the installations shown in Figs. 1 and 2. This makes it possible to send up several loaded ash cans at once, disposing of a day's accumulation or more at one trip and releasing the attendant for other duties.

A convenient pitted stoker installation is shown in Fig. 4 where the hopper is filled from an overhead coal bunker holding about 10 tons. This bunker extends several feet above grade and is filled through a coal door by direct shovelling from a motor truck. When necessary the coal supply from the bunker to the hopper can be shut off by means of the slide valve shown. This hopper arrangement has proved a very satisfactory labor saving device in that it completely avoids rehandling of the coal. Ample access has been left around the stoker, and the pit extended far enough to the left side to provide a place to set an ash can while the fire is being cleaned.

Stoker at Floor Level, Boiler Base Elevated

The raised-boiler-base stoker installation shown in the 50 in. cast iron boiler, Fig. 5, is typical of what can be done where head room permits. In this scheme the height of the combustion chamber is increased without placing the stoker mechanism within the limitations of a pit. The arrangement is desirable, therefore, from the standpoint of accessibility, but cannot be applied in most cases as economically as pitting the stoker. One drawback here, as in the case where both boiler base and stoker are placed at floor level, is the height to which coal must be raised in filling the hopper. This difficulty is minimized, however, where a travelling hoist is provided as indicated by the overhead monorail shown in Fig. 5. The reason for the U shaped curve in the monorail above the hopper is to accommodate both coal and ash handling—one leg of the U leads to the coal bin and the other to the ash hoist.

These illustrations show stoker installations in cast iron sectional boilers. Similar arrangements can be worked out for practically any steel boiler of the various fire tube types. Some of the "fire box" type of steel boilers are made with extended water legs to give a high combustion chamber particularly adapted for stoker firing. This gives the equivalent height of a raised setting and at the same time provides additional radiant heating surface in the combustion chamber. Extended water legs are proportioned to give ample furnace height when the bottom of the water leg is set on the usual cast iron base section with the stoker installed at floor level.

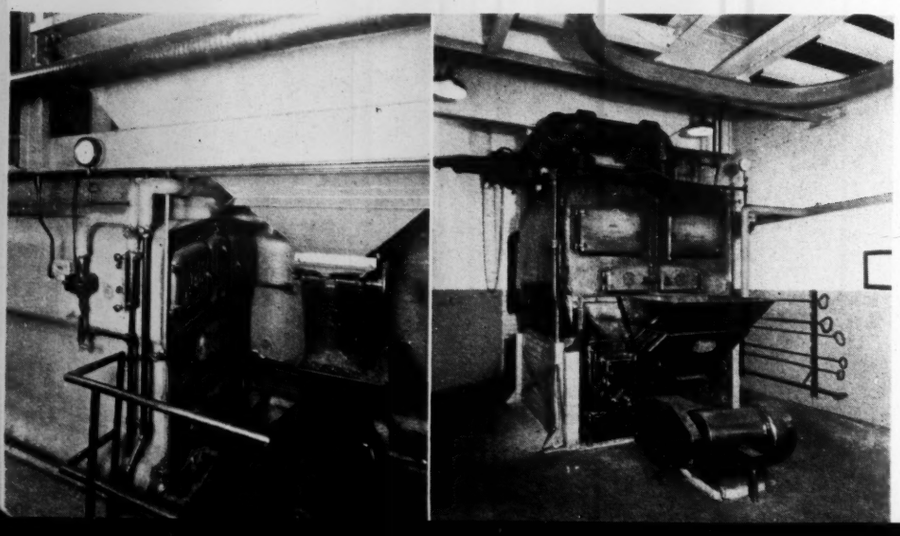


Fig. 4 (left)—Stoker in pit, boiler base at floor level; overhead coal bunker. Fig. 5 (right)—Stoker at floor level, boiler base raised

By **Rudolf Kuhlmann***

Conservation of Water Required for Air Conditioning

RIO DE JANEIRO may have the most beautiful water-front in the world, yet air conditioning engineers down here must contend with a water scarcity that presents a major problem on many installations. Practically no pressure is available from the city mains, and for many hours no water at all can be drawn. Common practice is to pump the water from the city mains to a roof tank. Frequently, an underground reservoir is also constructed to catch the water during the periods it is flowing, so it can be pumped later to the roof tank. Various methods are used to conserve water.

Sometimes a cooling tower is constructed, such as the one on the roof of the Sul America Insurance Company building in Rio (Fig. 1). This installation, using two 10 hp refrigeration compressors, has provided conditioned air for a basement vault and office space since 1932. Two business men, it is said, rent safe deposit boxes here that they may spend the hours from 12 to 4 in comfort during the extremely hot weather.

An effective method of coping with the water problem is employed in the 9 ton installation that cools the show-room space of the Lojas General Electric on Avenida Rio Branco. In connection with three 3 hp compressors, an equal number of evaporative condensers (Fig. 2) is used. Each has a fan with a ⅛ hp motor and uses about 25 gal of water per hr, which is approximately 1/20 of the water that would be required for the ordinary water cooled condenser figured on the basis of 2½ gpm per hp.

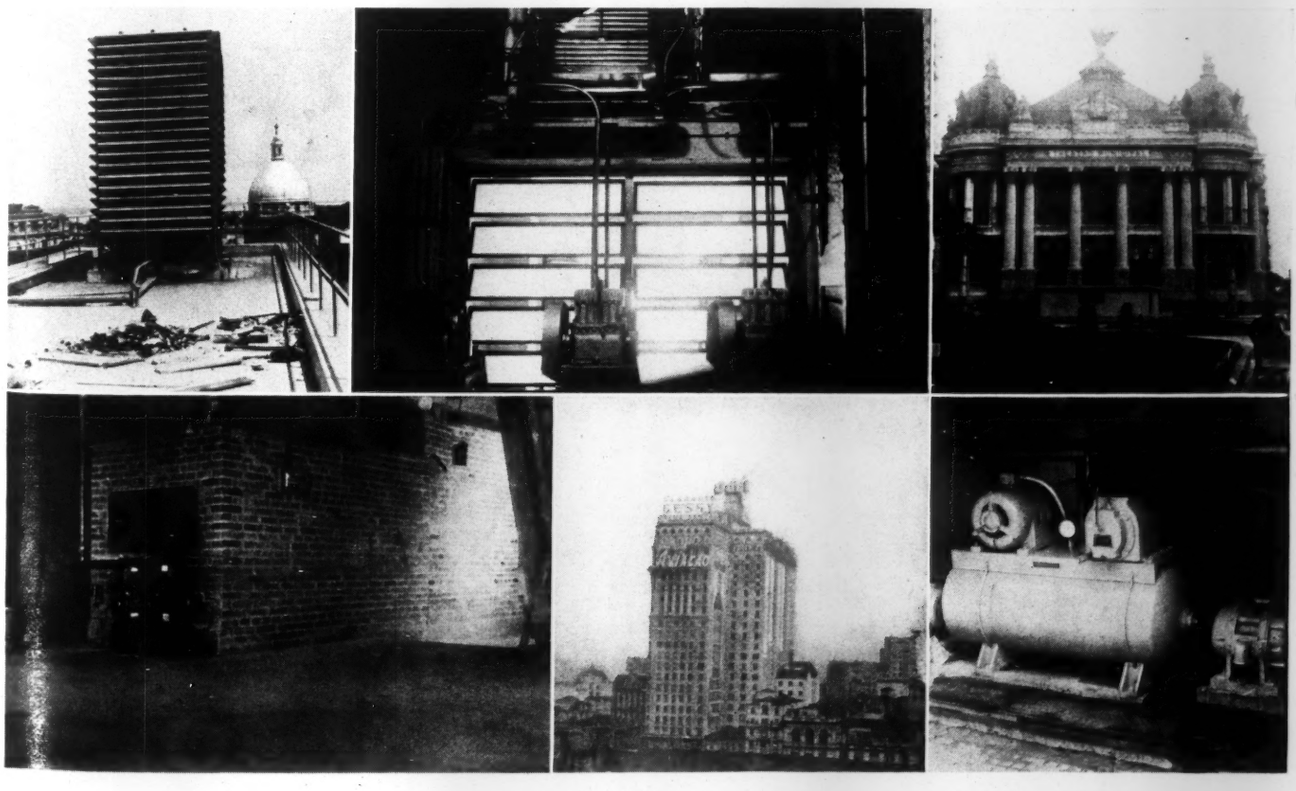
The refrigeration plant of the largest brewery in Brazil finds the spray pond method of cooling the condenser water for re-use very satisfactory. The temperature of the water as it enters the spray pond is 122 F and upon returning to the condensers, 84 F.

In a residence at Ipanema (suburb of Rio de Janeiro) it was found practical to dig a well for water supply. The total cost of sinking the well and installing pumping equipment was under $500 and water at 68 F is secured whereas the city water temperature at the tap is about 78 F.

Two installations in Rio have avoided wasting city water without the necessity of installing water re-cooling equipment. One of these is in a residence near the famous Copacabana beach. From an 8,000 gal concrete tank under the garage, the water is pumped to a smaller roof tank to provide the necessary pressure. With this

*Engineer, New York, N. Y.

Top, left to right—Fig. 1—Cooling tower on insurance company building in Rio. Fig. 2—9-ton installation for cooling showroom space. Fig. 3—Municipal Opera House to be cooled with ice . . . Bottom, left to right—Fig. 4 (interior)—Boiler on 25th floor of building shown in next view. Fig. 4 (exterior)—A boiler is installed on 25th floor of this building. Fig. 5—These pumps furnish water for surface cooling, the water later being returned to the city mains



large amount of water stored underground, the make-up of fresh city water required to supply the household needs provides enough cooling for satisfactory operation of the two 3 hp compressors. In another installation in the Jockey Club on Avenida Rio Branco, water for the condenser of a 5 hp compressor is taken from the roof tank and fed back into the underground tank. Use of water for the building needs is so large that the slight increase in temperature caused by the condenser is not noticeable.

One of the most striking air conditioning projects is the system being installed in the Municipal Opera House (Fig. 3) in the heart of Rio. Ordinarily, this building would require about 300 tons of mechanical refrigeration. However, due to its infrequent occupancy, it has been decided to cool with block ice. When in operation, this Opera House will be the best customer of the largest ice producer in Rio, using about 1/10 of its total capacity. In providing for the water requirements of this job, the melting of the ice will be of some help.

In Sao Paulo (the Chicago of Brazil), the water supply is much better. Here, I saw the solution of a water problem of a different nature. The Martinelli building, highest in the city, had used electricity for heating its domestic service water until a year ago. Although there is a special monthly power rate of about 3/10 of a cent per kw-hr for heating domestic water in Sao Paulo, even this was found too costly. When it was decided to install a steel boiler and an oil burner, the difficulty and expense of building a 27 story chimney arose. Therefore boiler, burner and oil tank were all taken up to the 25th floor, where a very satisfactory installation has been made (Fig. 4).

Perhaps the most unusual method of disposing of the water situation was that employed in Santos (greatest coffee port in the world). Here, there is an air conditioning installation in the local branch of the Companía Telephonica Brasileira; the water is pumped from the city mains through the surface type coolers and then returned to the mains. The pumps (Fig. 5) are needed to overcome the friction of the coolers and to provide a fast water flow. Although no water is wasted and the temperature is increased only from 72 to 75 F, the city makes a charge on a daily flow basis.

The variety of solutions for the water problems here outlined indicates that the engineers of Brazil are resourceful in overcoming difficult situations. As a matter of fact, with the expanding use of air conditioning, engineers in other countries of more abundant water supply may soon be required to give the same serious consideration to this important problem of water conservation.

Safety Drilling

THE use of ever higher temperatures and pressures in petroleum refining and other chemical engineering installations, coupled with the increasingly corrosive oils now put through cracking units, has created a dangerous explosion hazard which customary methods of construction and inspection have failed to remedy satisfactorily, according to the "Industrial Bulletin" published by Arthur D. Little, Inc. Following, however, a petroleum refinery explosion a few years ago in which a number of his friends were killed, a well-known chemical engineer developed a method of great simplicity to give advance warning of impending failure of high-pressure equipment. Numerous installations since made indicate that this development, along with customary inspection methods, substantially eliminates the grave danger of heavy loss to life and property heretofore existing.

Conventional inspection methods for high-pressure equipment consist largely of tapping the sides of equipment with a light hammer during periods of shutdown to detect areas worn thin, and of boring holes at suspected points to determine the thickness of the piping or other equipment. The deFlorez method, called safety-drilling, supplements these incomplete and intermittent checks by drilling the walls of the equipment with small holes, at fairly close and carefully determined intervals, to the depth of the lowest safe thickness limit. When corrosion occurs to thin the wall to this point, leakage is evidenced by a thin trickle through one or more of the small holes present at the worn section. By this means local failure occurs harmlessly and warningly while the wall as a whole is still strong enough to withstand general failure and to permit operation to continue with safety until such time as the plant may be shut down.

The safety holes are conically tipped so the trickle increases as wear continues and so any obstruction which might otherwise interfere with leakage is dislodged. To prevent corrosion of the holes when the exterior of the equipment is subject to corrosive conditions, the holes may be plugged up with some material which will blow out or permit the contents of the equipment to pass should failure occur. The amount of metal removed by safety-drilling is so small that the drilling is reported not to impair the strength of the equipment drilled, as has apparently been proved conclusively by bursting tests. Data on installations are accumulated to determine best standards for size of the holes, spacing, and other means to facilitate further practical use of safety-drilling both for petroleum refining equipment and for the numerous other types of related equipment for which it is not yet used.

PIPE WELDING—

Practical Field Testing and Instruction of Welders

By **D. O. Ferguson***

A PROGRAM of welding instruction and testing based on the idea of helping the welder, providing for his development, and insuring good pipe welding is described here. Last month the types of welds made and tested were discussed, preparation and testing of the weld coupons was described, requirements for a satisfactory weld were explained, and welding instruction briefly outlined. This month the classification of welders, follow-up tests, reports to welding supervisors, office records, etc., are covered.

Classification of Welders

After the welders successfully pass the welding test, they are classed as either "B," "A," or "AA" welders, depending upon their ability as shown by the tests; and each of them is assigned a steel stencil stamp. This stamp may be "A-1," "B-1" "B-2," etc., and is used to identify the welder who makes the welds as the pipe is stamped with this number immediately adjacent to all welds. This number is stamped in two places diametrically opposite for ease of finding when the pipe is to be buried, and in one place if the work is to remain above ground. This number is considered the welder's "permanent number," and might be considered a contracted form of his name, as numbers are never re-issued in the event the welders discontinue welding for some reason.

Some comment has been made from time to time as to whether the steel stencil number could be read if a weld failed several years after it was made. I can say frankly that I do not know, but it usually happens that welds fail soon after they are made if they are going to fail at all. Besides that, I believe that the act of reaching for the stencil and placing the identifying number on the pipe reminds the welders of their responsibility each time they complete a weld. In my estimation, when a weld is made and not stamped, it comes under the classification of an anonymous letter. We find that our welders insist on making the entire weld before they will place their number on it, and will not allow other welders to help complete the welds which they are going to stamp.

The welders are also issued "Welding Qualification Cards" for a six months' period which bear their "permanent number," their names, the class of welding for which they have qualified, the date the card is issued, the date the card expires and my signature. We use different colored cards for the various welding classes, that is, red cards for Class "B" welders, yellow cards for Class "A" welders, and blue cards for Class "AA" welders.

The welding classes are as follows:

Class "B"

Special welder on rolling pipe line welds and top connections. A welder in this class is permitted to weld where the work can be turned as the welding progresses, and also where the weld is made in such a position that down or flat welding can be done. Service tees, or other top connections which do not require overhead welding, can be done by a welder holding this type of welding qualification card.

Class "A"

Bell hole, or tie-in welder, including rolling welds, top connections, and welded pipe fittings. A welder in this class is permitted to do the regular line of pipe welding, and must also be able to lay out and weld pipe fittings.

Class "AA"

General purpose welder, including vertical, 45 deg position, bell hole, and backhand welds. This welder must also be able to lay out and make pipe fittings. In addition to these requirements, we do not issue a Class "AA" card to a welder until we obtain a favorable report from his immediate superior as to his reliability and desirability as an employee outside his welding ability. We consider the welders in this class our best welders.

Follow-up Tests

Follow-up tests are made from time to time depending upon our judgment as to the ability of the welder, and also depending upon what welding class he is in. We pay more attention to Class "B" welders than we do to Class "A" welders, and more attention to Class "A" welders than we do to Class "AA" welders.

In some cases, the follow-up tests are made in the same manner as the preliminary tests, only more time is spent on instruction and the welder is generally limited to a particular type of weld. For instance, we may be trying to qualify a Class "B" welder for Class "A" welding. In that case, we do not have him waste his time, or our time, trying to make 45 deg, position, vertical, or backhand welds; but confine his activities to straight overhead, or tie-in, welding.

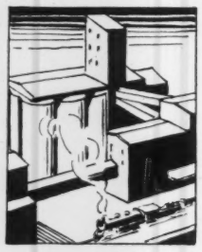
Sometimes the follow-up tests and checks will consist of going out on the job and removing welds which the welder has made prior to our visit. We call these welds production welds, that is, welds made in the ordinary course of a day's work under the actual field conditions surrounding the welding installation, and without knowledge that the welds were going to be tested. In the event that these welds show defects, my assistant will work with the welder and help him until the defects are eliminated.

*Welding Engineer, The Ohio Fuel Gas Co., Columbus, Ohio.

Presented at the Fourth Annual Welding Conference, Department of Industrial Engineering, The Ohio State University, Columbus, Ohio.

When a production weld is cut out, we select the coupon, with the exception of the nick break coupon, from what we think are the good and bad portions of the weld in order to obtain an average test of the joint. I might confess that sometimes the coupons we think are bad turn out to be very good, and *vice versa*. I have had a number of years of experience in supervising and training welders in an engineering capacity, and Mr. Mock, my assistant, has had about ten years' experience in earning his living by welding; but still we are not able to recognize a good or a bad weld *solely* by its appearance. In view of our experience, we question the advisability of attempting to judge a welder's ability by the finished appearance of his work. This practice is more common than might be thought.

At first thought, it might seem better to confine the follow-up tests entirely to production welds, but this is not practical due to the fact that the welders are generally scattered on small jobs. We were particularly gratified last summer when the production work of a number of our welders measured up to the standard of their test welds. I might say that we consider the training of welders in about the same category as football or basketball scrimmage. We feel that we have been able to prepare welders to meet their problems by working with them at convenient times.



We consider the follow-up feature a very valuable part of the welding program because we realize that all welders, regardless of their experience and qualifications, will tend to slip back from time to time. We recognize this fact clearly, and try to reach them before this slip back becomes serious. Additional welding instruction is given at this time, and an attempt is made to qualify the welder for the more complicated types of welding. I would like to say that I consider that a continuous follow-up program of welding instruction and tests is necessary for successful welding control; and that one test, or one instruction period, will not solve any company's welding problem for all time.

Welding is an individual problem, and is full of the factor of human element, so too much care cannot be taken in selecting and training welders. In our business, the welder and his helper have replaced to a large extent the old time tong crew on a screw pipe installation, and the wrench gangs of the plain end pipe installations. At the same time, the welder has assumed the entire responsibility of these crews. To make matters worse, the welder is generally the only one on the job who knows anything at all about what he is doing. All of these considerations call for a welder carefully selected, thoroughly trained, and checked occasionally by men trained in checking and instructing welders.

Miscellaneous Reports to Welding Supervisors

Two copies of the reports of all welds tested are sent to the welder's immediate superior, and attention is called to the defects discovered. Specific recommendations are made, and these usually concern practice by the welder in making the type of weld which is causing him trouble.

Short pieces of scrap pipe are used by the welder for this work. The welder cuts out coupons with the cutting torch from the practice specimens, nicks them in the weld with the torch, and breaks them in a vise for examination for defects. He also selects the portions of the weld where he has been having trouble in order to see whether or not he has eliminated the defects.

Of course, we are not present during this practice session and this type of testing, but we show the welder during our initial contact with him how to recognize a bad coupon from a good one by a visual examination of the fractured weld. In this way, our work of qualifying welders is speeded up because they will eliminate some of the obvious defects, and are more or less ready for the formal tests when we visit them. They may need some polishing up, but concentrated practice by them along the lines as recommended by us speeds up their qualifications materially.

A classification of all the welders in the company is sent periodically to all of the department heads whose departments deals with welders, as well as to the general foreman, district manager, and other field welding supervisors so that they will be informed as to the ability of all welders in the company in the event they wish to borrow a welder from some other department for emergency work. This also stimulates department interest in having their welders compare favorably with the welders in other departments.

The various welding classification cards, that is, "B," "A," and "AA" are also sent to the department heads concerned when they are renewed so that their attention will be called to the ability of the particular welder in question. Any changes in classification, such as "B" to "A," or reverse; or any notification of a welder having his card revoked is also sent to the department head concerned so that he will be kept advised as to whether his welders are improving or becoming worse. In the event their welding cards are revoked, the welders are not permitted to make any welds until they are requalified by us. When a welding card is revoked, it also usually means that the welder is discharged or laid off for a two weeks' period. Fortunately, we have not had to take this step except in the case of one or two welders.

Miscellaneous Features of Program

A copy of all of the tests of welders is kept in my office, as well as an individual record of each welder. This record shows the date of the test, the number of tests made to date, the types of welds tested, and the results of the test. In this way, I can tell in a rapid manner when we last visited the welder, the quality of his work, the types of welds which he is trained to make, etc.

An up-to-date classification of all welders is also kept in my office showing the class of work for which each welder is qualified, and also showing when his welding card was issued and when it will expire.

In one company we have a welding committee which is composed of all department heads having welders

under their jurisdiction. These men tie-in our work in the field with the management end of our business. We are able to keep this committee fully advised as to the welding situation, the improvement of the welders, and the necessity of a continuous follow-up testing and instruction program through reports sent either to the individual members, or to the committee as a whole.

In addition to training the welders and making periodic follow-up tests of their welding ability, we have succeeded in getting some of the companies to use pipe dollies and lining-up clamps to assist in preparing joints for welding.

We have also succeeded in eliminating some of the field fabrication of heads for making up headers, tank ends, drips, etc., by buying shop fabricated forged steel heads. These heads are attached by a straight rolling girth weld, and simplifies the end connection materially. I believe that simplification in design, and the use of shop fabricated heads, etc., will result in getting better welds, and will also result in many cases in more economical welding.

I might make mention of the torch beveling devices which were also developed in one of our shops. This device provides an easy and economical method for reconditioning pipe, and really amounts to taking the machine shop to the pipe pile. It is true that pipe can be beveled with a hand cutting torch, but, generally speaking, the cuts are not true, and usually the slag left from the cutting operation is so hard to remove that it is not thoroughly removed. A poorly made cut will provide a bad line-up, and will increase the cost of welding, and I can assure you will do nothing towards increasing the quality of the weld. We have been able to reclaim a considerable amount of casing from the gas wells operated by the company for use as either distribution or transmission lines, due to the beveling devices. As far as the welder is concerned, this pipe is as good as new pipe, since cuts made with the beveling devices compare favorably to bevels made in pipe walls with machine tools. We have found that the thin blue black skin left on the cut surface *does not* affect the quality of the weld, and *need not* be removed. The latest model of our beveling device will accommodate the regular cutting torch, and can be adjusted to cut any desired degree of bevel.

Summing Up

In conclusion we feel that this type of program is valuable both to our company and to our welders for the following reasons:

1—It is based on the idea of helping the welder, and through him helping the company to obtain better and more economical work.

2—It provides the welder with a definite goal to attain, and stimulates welding interest by providing for advancement from the "B" class to the "A" class to the "AA" class.

3—It definitely specifies what we want in the way of welding, and does not ask the welder to be a mind reader or a designing engineer.

4—It provides sympathetic help and aid to welders in overcoming welding problems which may have been bothering them for some time.

5—It makes for a better dissemination of welding information, and enables the good ideas of all the welders to become common knowledge.

6—It eliminates the possibility of welders being hired in a hit or miss manner, and having their ability judged by men not in a position to judge the quality of a weld.

7—It classifies the welders so that we are able to use the least experienced on work permitting this type of welding.

8—It provides for the development of welders from the rank and file of our employees, and makes it unnecessary for us to depend upon outside welders trained in a manner unsuited to us.

It also makes it possible for us to have a combination welder and pipe fitter, welder and service man, welder and machine operator, etc. This arrangement is most suitable for us, particularly in the smaller districts where the full time services of a welder are not needed.

9—It provides a way of keeping the good and bad points of a welder in the mind of his immediate superior. Full credit is given to good performances by the welder, but any indication of carelessness on his part is also brought to the attention of the welding supervisor. Repeated carelessness is brought to the attention of his department head.

10—It keeps the welders on their toes because each weld is positively identified by the stencil, and the welders do not know when one of their production welds may be cut out. We may cut out a production weld from a pipe pile in Columbus next week which was made one hundred miles away two months ago, but the welder and his supervisor are sure to hear about it, whether the results are good or bad.

11—It provides a central control of welders which is able to take full responsibility for training, classifying and improving welders, and for setting uniform standards for welding. This control can also prevent any welder from welding by revoking his qualification card.

We have been very successful in dealing with the welders, primarily because we go to great lengths to let them know that we are trying to help them. This type of program is also popular with the various welding supervisors, field foremen, etc., because the welder is helped and makes a better employee. It also relieves them of the responsibility of judging the quality of work with which they are not familiar, as they are asked only to limit their welder's activities to the type of welding for which he is qualified, and to be responsible for seeing that he does not loaf on the job. We believe that we understand the trials and tribulations of a welder. We know that welding is a hard job physically; and due to the convenience of welding, the welder is often called upon to weld in almost every conceivable position, and under almost every possible condition. We feel that the best way to improve any company's welding is to improve the welders, and that this requires individual attention to the welders, and concentrated instruction and help should be given them by an experienced instructor who is also a first-class welder.

We also feel that inspection alone has been overemphasized in the past, and that welders rejected by one company have been turned loose with no improvement to become employees of another company.

PRACTICAL HEATING

By **Harold J. Taylor***

QUITE often it is found that a room is near the boiler room and if radiation were installed on the ceiling, the heat would not properly distribute itself, especially near the floor. In a case of this kind, providing that installation of piping will permit, a radiator can be installed at a point below the water line of the steam boiler.

It should be placed on an exposed outside wall if possible. Be sure that it will fit between the openings on the boiler; that is, that the distance between the supply tapping for the indirect heater and the return opening of boiler is more than the distance between the supply and return tappings of the radiator.

The supply piping to the radiator pitches down to the radiator and the return piping to the radiator pitches up to it. The supply piping to the radiator must not be trapped; in other words, this line must not be carried above the water line of the boiler at any one point or above the point at which it leaves the boiler tapping. If, in running the return line back to the boiler, it is found necessary to drop below the return opening of the boiler, do so.

Install top of the radiator as high as water line will permit.

Elimination of air and expansion of water is cared for by the boiler.

To connect up a radiator on this type of job, run a 1 in. pipe line from the supply tapping for the indirect heater to the top supply tapping of the radiator. The return from the radiator may be taken from the same end of the radiator and this line is connected into the return opening of the boiler.

If an indirect heater is installed, then increase the pipe size to the heater and in place of an elbow at top of heater, install a reducing tee fitting. Example: If boiler tapping is 1½ in., and heater tapping is 1 in., then use a 1½ x 1 x 1 in. tee on the run. Into the 1 in. outlet on the run, connect up to the supply tapping of the radiator. In some cases it may be necessary to tap the boiler for this type of installation. If the smoke pipe should be in the way of the supply piping between radiator and heater, then tap the boiler on the opposite side of the smoke pipe. This supply piping must not be trapped.

In the return line from the radiator, install a gate valve for regulation of temperature. If automatic regulation is desired for this radiator, then install a motor operated valve in the return line to the radiator and connect this valve to a thermostat.

To figure for radiator size, figure as for steam and add 40 per cent. Do not add 60 per cent as would be done for water over steam.

Installations of this kind are working to entire satisfaction on a number of jobs. For instance, at the U. S. Fish Hatchery, Northville, Mich., the boiler was tapped 2 in. and from this tapping was run a 2 in. pipe line for a distance of 90 ft and returned to the boiler (total lineal feet of pipe installed, 180). This pipe line was installed under a long trough where sorting of some kind is done. Heat was wanted only at this particular point and this hook-up did the job 100 per cent.

*Contracting Engineer, Detroit, Mich.

"What Air Conditioning Did for My Business"

BENNETT Schneider has a 12 by 24 ft book shop in the Country Club Plaza district of Kansas City, Mo. He has been in business in the same location for six years. Winter volume always has been good. Summer volume always slumped dangerously. Last summer he installed a single 1½ ton air conditioning unit. So crowded was his shop, that there was but one place for the unit—over the door.

There, as a sentinel of sales, it barred summer heat and humidity and the summer of 1934 brought to Mr. Schneider's book establishment sales volume rivaling that of the winter months.

"Before we put in the air conditioning unit," Mr. Schneider said, "the shop was unlivable. People wouldn't stay five minutes. We let our promotional activities slip because we were too exhausted to do much more than keep the shelves arranged and make our daily bank deposit.

"With air conditioning of the shop, our customers began to browse around—and in a book store browsing means buying because a customer who will enter a book store is the type who finds it hard to resist purchasing a book in which he has become interested.

"On the other hand, the shop personnel was kept so comfortable that more pep and selling ideas were evidenced in the summer months than in the winter. This, in turn, helped boost sales volume.

"Customer comments came so frequently that we actually became tired of hearing them. It was a lucky day when we decided to air condition our small shop." —James W. Irwin.*

*Frigidaire Corp., Dayton, Ohio.

Modernizing Buildings for Profit

THE amendment to the National Housing Act providing for modernization credit up to $50,000 for improvement of commercial and industrial properties, which was approved just as the June H. P. & A. C. went to press, is aimed to stimulate modernization of "Main Street" and, says Acting Federal Housing Administrator Stewart McDonald, "opens a new market which should be of direct benefit to all industry and of indirect benefit to the nation as a whole." One form of modernization which undoubtedly will receive increased attention is the installation of air conditioning systems for profit, as air conditioning has been proved a business getter for enterprises which depend upon attracting the public — stores, theaters, restaurants, hotels, shops, etc. In fact, according to George W. Mason, head of Kelvinator, raising of the property improvement loan limit will be the greatest single spur to the development of air conditioning this year. Improvement of plant and building heating should also be stimulated, as this is another type of modernization which "pays for itself" in consequent savings.

Use of Credit Extended

The credit extended under the $50,000 amendment is for the purpose of (1) repair, alteration, or improvement of real property already improved by, or to be converted into, apartment or multiple family houses, hotels, office, business or other commercial buildings, hospitals, orphanages, colleges, schools, or manufacturing or industrial plants; or (2) the purchase and installation, in connection with the foregoing types of property of such equipment and machinery, with or without any structural changes in the buildings, as are peculiarly adapted to the business conducted therein or necessary to the operation thereof.

Maximum limit of credit obtainable for each separate property is $50,000, and cost of architectural and engineering services is eligible for modernization credit. Maximum amount of credit for the improvement or modernization of individual homes and other classes of property mentioned in the original act remains fixed at $2000, according to the FHA.

Examples of Modernization

In considering the modernization of a plant or building, the experiences of others (such as have been reported in many issues of H.P.& A.C.) are most important to the preliminary decision regarding a proposed investment in property improvement. What work should be done, what will be its cost, and what advantages may be expected, may be approximated by the experience of others and determined more accurately by an engineering survey of the particular property under consideration.

A timely book entitled "Modernizing Buildings for Profit" has recently been published[1], and includes numerous examples of improvement and modernization of apartments, hotels, restaurants and bars, shops and stores, office buildings, theaters and homes, as well as a general discussion of the objectives of modernization, what to modernize, how to get started, etc. The author, Kenneth Kingsley Stowell, is a member of the *American Institute of Architects* and was formerly editor of an architectural magazine; while his book is perhaps more directly of benefit to the architect, the mechanical equipment of buildings is not neglected.

For example, in his discussion of theater modernization, the author points out that advances in heating and air conditioning offer a large choice of improved equipment that will increase the comfort of patrons and staff (in this connection, refer to the survey of theater air conditioning and heating by D. D. Kimball in the December, 1934, and January, 1935 issues of H.P.& A.C.). Mr. Stowell states that air conditioning can be provided in "degrees of completeness" through the progressive installation of the necessary equipment.

Considerable attention is devoted to heating in the chapter on office buildings, and a check of the entire system from boiler to topmost radiator is recommended. Newer types of heating equipment are mentioned and importance of zoning and insulation for economy in fuel consumption is discussed; the possibilities of buying steam to avoid renovation of the present boiler room and to release space for rent may be found worthwhile, says the author.

When the author turns to restaurants and bars, air conditioning is of course featured, including the possible arrangements between tenant and building owner for installation of the equipment; in a "case history" describing the modernization of a hotel lobby and dining room with air conditioning, credit for trebling the restaurant business is attributed to the cooling system.

Advantages of Air Conditioning

Several examples of modernization by air conditioning were recently reported by S. F. Myers of the Westinghouse Electric and Manufacturing Co. To increase hot weather business, the Jolly Cafe, Topeka, Kansas, was air conditioned in 1934; this installation has been quite successful, increasing business 75 per cent. The complete installation cost approximately $2800, and the operating cost is about $2 per day. It is in use about 100 days a year, 7 hours a day.

The Waffle Shop, Memphis, Tennessee, air conditioning system has increased business about 50 per cent. Before air conditioning, 350 meals a day at an average check of 32 cents were served; now 450 meals at an average of 38 cents are served, and "steak business" doubled in midsummer after the installation. The system operates about 100 days for 24 hours a day.

Huyler's two dining rooms in the Palmolive Building, Chicago, are air conditioned and after the installation was completed the management was gratified to note an increase in business. In the summer the equipment is in use approximately 12 hours a day at a cost of 33.2 cents an hour for electric power and water.

Executive and business offices also benefit from the

[1] Publishers: Prentice-Hall, Inc., New York. 231 pp., 9 x 12 in., cloth-bound. $6.50.

advantages of conditioned air. In the offices of the United States Chamber of Commerce, Washington, D. C., the office of the chairman of the board, president, secretary to the president and the conference room are air conditioned, the units being installed in the radiator enclosures under the windows.

Bank owners have become air conditioning conscious and have installed extensive equipment, says Mr. Myers. The First National Bank, Phoenix, Arizona, is air conditioned, the equipment being designed to maintain temperature at 80 F with 100-120 F outside. Air enters the cooling coils through spun glass filters, is delivered to banking space through ducts, and the return grilles are underneath the depositor's counters. Tenant occupancy of this five story building has increased and rented area is ahead of nearby non-air conditioned buildings.

Always eager to adopt successful patronage building ideas, The Statler Hotels Company air conditioned 30 guest rooms in their Detroit hotel. The lobby, dining rooms, cocktail lounge, also were air conditioned at the same time. The guest rooms were kept filled at $1.00 per day extra charge. During June, July and August, the room count increased 17 per cent and the number served in the dining room increased 24½ per cent over the previous three year average.

Air Conditioning Offices

Air conditioning of offices, both general and private, is getting more attention. A windowless, air conditioned building is being erected at Hershey, Pa., to house the executive offices of the Hershey Chocolate Corp. Insulation of the building and prevention of heat leakage through the windows is expected to reduce materially the cooling and heating loads.

An air conditioning system was recently installed in the offices of the Cupples Co., St. Louis, Mo., to supply two floors of offices where some 100 employees work. Located on a platform suspended from the ceiling immediately outside of the office space in an insulated sheet metal housing is a bank of filters having 12,000 cfm capacity; direct expansion cooling coils for 30 tons capacity at 500 ft face velocity; humidifier sprays; tempering coils; and a 325 rpm belted blower of 12,000 cfm capacity. Two 15 hp, V-type, 4 cylinder condensing units in the sub-basement below the offices supply refrigerant to the cooling coils through hard drawn copper pipe.

A system of effective temperature control governs conditions both winter and summer. Winter control consists of a motor operated "on and off" steam valve controlled by the room thermostat. Tempering coils—one for each floor—are controlled by modulating type motor operated valves, which are controlled by thermostats in the return air ducts from each floor. Admittance of fresh air is controlled by a modulating damper in the fresh air duct. Humidity is controlled by a humidistat in the mixed air chamber, operating a solenoid valve in the water line.

Summer control consists of thermostats in fresh air and return air ducts, controlling solenoid valves in the liquid lines. Fresh air is controlled as in winter operation. Any amount of fresh air up to the fan capacity can be handled, permitting ventilation during those periods when heating or cooling is not required.

The heating controls are supplied with a week-end shutoff, so that the plant automatically takes care of itself over week-ends.

Ducts were designed for a velocity of about 1000 fpm in the main runs. Air is delivered through three-way grilles at a velocity of about 500 fpm. Return air grilles are so located as to necessitate movement of air through the entire building before returning to the blower. Return air is taken back from both floors.

Design conditions were (winter) 70 F and 40 per cent R. H. with 0 F outside, and (summer) 80 F and 50 per cent R. H. with 95 F and 46 per cent R. H. outside. The system was engineered by the Cooling, Ventilating & Sales Corp., and installed by the Sodemann Heat & Power Co., both of St. Louis.

Air conditioned office of Cupples Co.

Heating · Piping
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American Society of Heating and Ventilating Engineers JOURNAL SECTION

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Oil Burning in Residences

By **D. W. Nelson*** ***(MEMBER)***

Madison, Wis.

OIL burning is a very desirable means of heating residences, because of its automatic temperature control and the almost complete lack of attention required to the heating plant throughout the heating season. In order that oil burning may hold its competitive position in the future with other methods of heating, it will become increasingly necessary to eliminate losses and inefficiencies that result in excessive heating costs.

In the past it is likely that too many installations have been made in a haphazard way. Too often the salesman has been only interested in the placement of the burner and has entirely ignored probable costs of heating. Many burners have been installed in undersized or inefficient boilers or furnaces. In some cases the combustion chamber design has been incorrect and in others the rate of burning has been much higher than required by the heat losses of the residence.

The study in the present paper was made to investigate at least one of the losses and to make a survey of actual installations in residences as to the efficiency of oil burning.

This report is divided into two parts. The first concerns an analysis of losses occurring during off-periods in the operation of intermittent types of burner. The second concerns the results of a survey of a large number of residence installations as to efficiency of combustion as determined by CO_2 and flue gas temperature readings and other related items. The work was done under a project[1] of the Civil Works Administration and later had the assistance of students enrolled under the Federal Emergency Relief Administration.

Most burners work on the intermittent principle. When the call for heat is made the burner starts, and the combustion improves as temperatures increase in the brick work of the combustion space. The burner runs varying lengths of time and makes a varying number of starts depending upon the heat requirements of the building at that time. The newer temperature control systems give very close regulation of temperatures, and the running periods are consequently shorter and more frequent. This tends to increase the off-period losses which result from the cooling off of brick work and heating surfaces with the passage of air through the heating unit while the burner is shut down. Most burners operating on the high-low flame principle are subject to a somewhat similar loss due to a lowered temperature of the combustion space and a larger percentage of excess air during the low flame periods.

Laboratory Investigation

The present study was made on a pressure atomizing burner with positive or fan air supply. The tests were made on a laboratory installation completely equipped for testing and on a residence installation under actual conditions of heating.

Fig. 1 shows a diagrammatic sketch of the laboratory test equipment. The boiler used was a 10-section rectangular cast iron water tube steam boiler having about 87 sq ft of heating surface, and was a coal burning type often used for oil burning. With a 2½ gal nozzle, the maximum load developed was about 850 sq ft of radiation. The net combustion space for oil burning was 8 cu ft. For the purpose of these tests a closely fitting damper was placed in the smoke pipe near the boiler outlet. The tests were made to determine the difference in efficiency with various on and off periods for operation with and without the damper. When the damper was kept in the open position at all times, the operation corresponded to the usual method of operation with this type of burner. This was compared with operation when the damper was closed manually as soon as the burner stopped and was opened 1 min before the burner started. With each of the two types of operation various percentages of off and on time were tried. The on periods were 10 min and the off periods were of varying length. For instance at 50 per cent operating time the burner would be on 10 min and off 10 min and at 25 per cent operation it would be on 10 min and off 30 min.

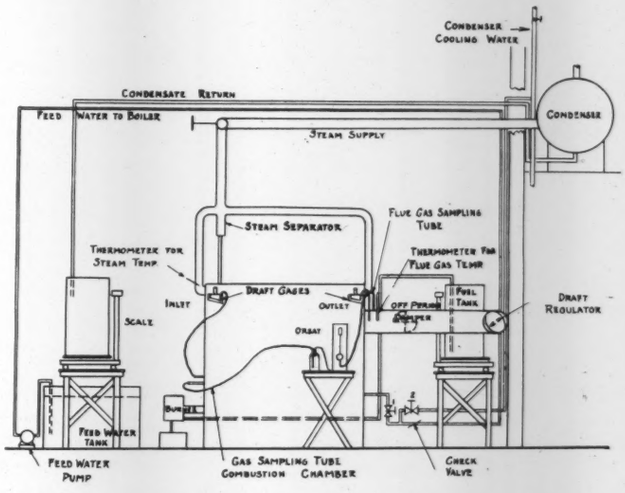

Fig. 1—Arrangement of laboratory equipment to determine off-period losses

The CO_2 analysis was maintained at 10 per cent with No. 2 distillate fuel burned at the rate of 2½ gal per

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*Asst. Professor of Steam and Gas Engrg., University of Wisconsin.

[1]The following worked on this project under CWA: W. F. Bakke, E. P. Hansen, L. E. Heger, F. C. Rossow; and the following under FERA: R. H. Amundson, G. W. Androne, H. C. Mittelstaedt, R. H. Newbury, and R. A. Wilson. Project carried on in the Dept. of Mech. Engrg., University of Wisconsin, Prof. G. L. Larson, Chairman.

Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Toronto, Ont., Can., June 1935.

hour. The flue gas temperature measured about 450 F. A draft control was used and an effort was made to maintain 0.02 in. in the combustion space. Due to the windy weather at the time of some of the tests and to an oversize chimney, difficulty was experienced in holding this steady and as a consequence it was found difficult to always get consistent results. A draft regulator was used at the location shown in Fig. 1. The results of the tests are shown on Fig. 2 for both types

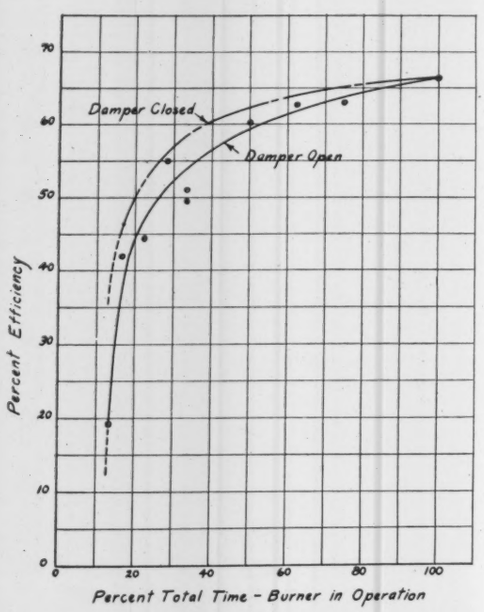

Fig. 2—Comparison of efficiency with and without the off-period damper

of operation. The maximum efficiency secured at continuous operation was 66 per cent. The CO_2 determination of 10 per cent and the boiler outlet temperature of 450 F indicates an efficiency of 82.5 per cent. The reason for this difference of 16.5 per cent is not known. The stack gases were not analyzed for unconsumed hydrogen or hydrocarbons. It is suspected that the heat loss to the base and floor was large as the combustion space was partly below the water cooled surface of the boiler. This arrangement was made because of a drop section in the boiler useful in connection with the hand firing of bituminous coal. This loss might have been reduced by the use of insulation between the bricks and concrete base and floor or by the use of insulating bricks.

With the interpretation of the test results as made by the placement of the two curves of Fig. 2, the saving due to the use of the damper appears as the vertical distance between the two curves. These differences plotted on Fig. 3 show the greatest saving for the damper for the shortest periods of operation. It would seem for best efficiency that the burner should operate almost continuously under maximum heat requirements. In this locality the average load is about one-third the maximum. This indicates an average loss of about 9 per cent that might be eliminated by the prevention of air circulation through the combustion space during off-periods.

The second part of this study of the off-period loss was made in a residence heated by a pressure atomizing burner installed in a rectangular steam boiler of 8 sections. The system was a one pipe system with vacuum vents and the connected load was about 350 sq ft EDR. The boiler catalog rating for coal burning was 900 sq ft and the net rating would be about 450 sq ft. The rate of oil burning was 1.8 gal per hour which resulted in a boiler stack temperature from about 500 F to 550 F. The draft regulator setting was kept constant on all tests. A fuel burning rate of 1.8 gal per hour gives ample capacity for the warming up period in the morning when operated on dual (lower night temperatures) control. The system operates on pressure control for several hours during the warming up period in cold weather indicating sufficient burner and boiler capacity, but this does indicate insufficient radiation for this type of operation. Heat loss calculations indicate the installed radiation as being sufficient to meet the maximum losses but there is no reserve for rapid heating up after the temperature has been allowed to drop to 50 F. One downstairs radiator was not used during these tests.

The use of oil was measured by totalling the hours of burner operation by a self-starting electric clock

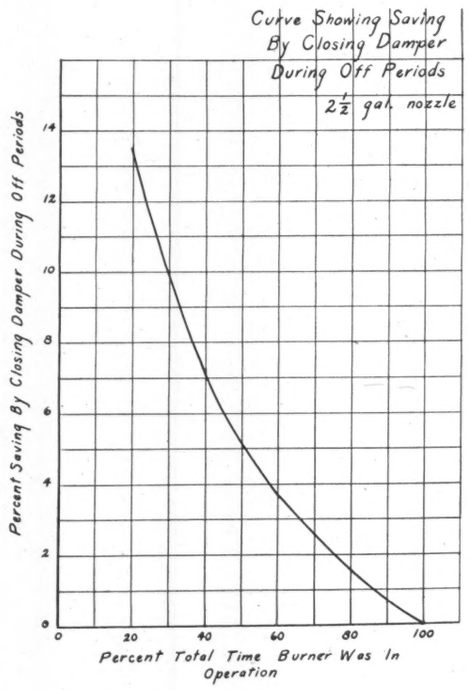

Fig. 3—Savings resulting from the use of the off-period damper at various percentages of running time

placed in the burner motor circuit so that it started and stopped with the burner. Since the oil temperature was practically constant because an inside oil tank was used and also since the same nozzle and the same atomizing pressure was used on all tests, the running times gave an accurate determination of oil use. An accurate fluid column gage on the tank was used as a check and the rate of consumption of 1.8 gal per hour was obtained by this means.

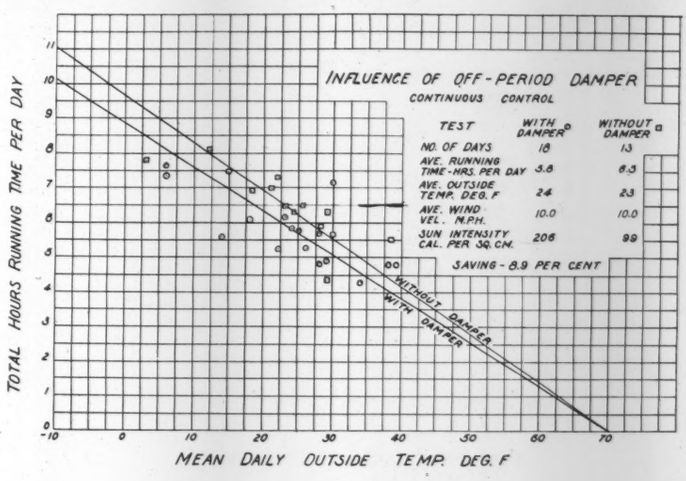
INFLUENCE OF OFF-PERIOD DAMPER
CONTINUOUS CONTROL
TEST
WITH DAMPER
WITHOUT DAMPER
NO. OF DAYS 18 13
AVE. RUNNING TIME-HRS. PER DAY 5.8 6.5
AVE. OUTSIDE TEMP. DEG. F 24 23
AVE. WIND VEL. M.P.H. 10.0 10.0
SUN INTENSITY CAL. PER SQ. CM. 206 99
SAVING - 8.9 PER CENT
WITHOUT DAMPER
WITH DAMPER
TOTAL HOURS RUNNING TIME PER DAY
MEAN DAILY OUTSIDE TEMP. DEG. F

Fig. 4—Results of off-period damper tests in residence with continuously maintained temperature of 70 F

An automatic damper was installed in the smoke pipe near the boiler outlet. The damper was operated by an electric motor similar to that used for operation of draft dampers on hand-fired installations arranged for thermostatic control. The room thermostat caused this motor to open or close the damper to suit the demands for heat. The oil burner was controlled through this damper by switches of the mercury type attached to its shaft. Whenever the damper was in the open position, the burner controls caused it to start and when the damper motor caused the damper to begin to close, the controls stopped the burner. The cycling controls of the burner allowed about a minute between the damper assuming the open position and the starting of the burner. The early breaking of the burner motor circuit upon the turning of the damper from the open position and the slow operation of the damper motor gave considerable time for burnt gases to be cleared from the combustion chamber at the close of a period of operation.

Tests with one system of operation were usually made over a period of a week and a sufficient number of days were taken to eliminate to some extent the variable factors of sun and wind effect which in addition to temperature differences influence the heat losses. The effect of the damper on the amount of fuel used was observed with continuously maintained inside temperatures and with dual or lowered night temperatures.

The results are shown in Fig. 4 for a continuously maintained temperature of 70 F and in Fig. 5 for daytime 70 F and night thermostat setting of 50 F. The outside temperatures, wind velocities and sun intensities shown on these figures are averages of readings secured from the local Weather Bureau Station.

The data on Fig. 4 show that the weather conditions were quite similar in the two periods of tests for continuous control. During the 18 days of tests with the damper in use, the temperature averaged 24 F, the wind velocity 10 mph and the sun effect 206 cal per sq cm. During the 13-day period without the damper in use, the temperature averaged 1 deg lower, the wind velocity the same, and the sun intensity 99 cal per sq cm. The running time with the damper in use was 5.8 hours per day and without the damper was 6.5 hours per day. When the correction is made for the 1 deg difference in temperature, the saving is 8.9 per cent. This saving in running time shows as the vertical distance between the two curves on Fig. 4 at 23 F. The sun intensity variation favored the period when the damper was in use which indicates that the real saving was somewhat less than 8.9 per cent. The scattering of the points of daily average temperature and the hours of burner operation can be explained when the sun intensities and wind velocities of individual days are examined. A point above the line is almost always a windier-than-average day and a point below is a sunnier-than-average day.

The similar comparison of damper operation when carrying reduced temperatures at night time from 10:30 p.m. to 5:45 a.m. indicated a saving of 7.2 per cent as shown on Fig. 5. In these tests of 32 days with the damper and 45 days without the damper, the sun intensities and wind velocities varied a slight amount, but in directions tending to balance each other so that probably these factors have not appreciably influenced the results. The temperature averages differed by 13 F, being 20 F for the period with damper use and 33 F without the damper. The carrying of lowered temperatures at night times does make a saving which differs at various outside temperatures. This influences the results of this damper study since the average outside temperature differed by 13 F in the two periods. The saving due to such dual control must result from smaller temperature differences. In this study of an off-period damper, the average running time of 6.0 hours at 20 F was corrected to 33 F by a ratio of temperature differences inside to outside with 20 F weather to temperature differences inside to outside with 33 F weather. In order to obtain these differences the inside room temperatures were averaged by

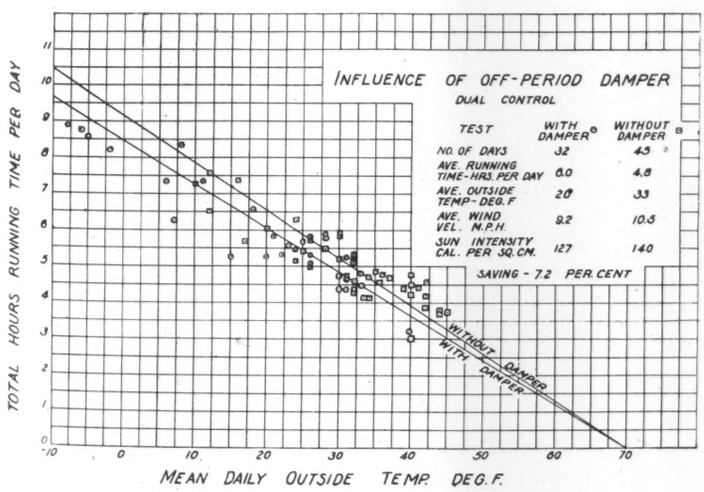
INFLUENCE OF OFF-PERIOD DAMPER
DUAL CONTROL
TEST
WITH DAMPER
WITHOUT DAMPER
NO. OF DAYS 32 45
AVE. RUNNING TIME-HRS. PER DAY 6.0 4.8
AVE. OUTSIDE TEMP.-DEG. F 20 33
AVE. WIND VEL. M.P.H. 9.2 10.5
SUN INTENSITY CAL. PER SQ. CM. 127 140
SAVING - 7.2 PER CENT
WITHOUT DAMPER
WITH DAMPER
TOTAL HOURS RUNNING TIME PER DAY
MEAN DAILY OUTSIDE TEMP. DEG. F.

Fig. 5—Results of off-period damper tests in residence with lowered night temperatures

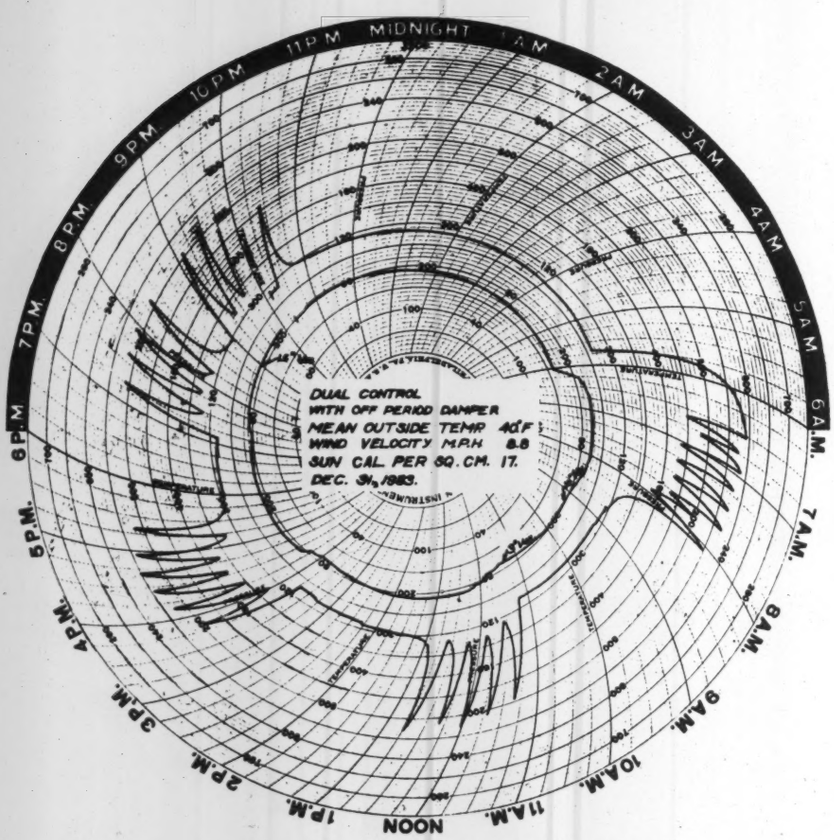

Fig. 6—Typical daily chart showing flue gas and boiler water temperatures with off-period damper in use

hours for each condition from recording charts. The curves on Fig. 5 as on Fig. 4 were drawn as straight lines through 70 F and a point established by the average running hours and the average outside temperature. The saving is approximately the vertical difference between the two curves at 33 F.

The saving found by the use of the damper was 7.2 per cent for dual temperature control and 8.9 per cent for continuous control. The latter figure is considered somewhat high because of differences in sun effects and the 7.2 per cent is considered somewhat low because of the method of damper operation.

The room thermostat controlled the operation of the damper. During the warming up period each morning, there was a time when the burner was controlled by the steam pressure limiting device which allowed the steam pressure to vary between ½ lb per sq in. and 4 lb per sq in. The colder the weather the longer the period of such pressure controlled operation and during all of this period the damper remained open continuously. Since the starts and stops are quite frequent and the brick work would be at a red heat, the loss in off periods during these warming up times would be appreciable. Therefore the figure of 7.2 per cent saving for the damper during the dual operation period is considered to be somewhat low.

Fig. 6 shows a chart of flue gas and boiler water temperatures for a typical day with damper operation and Fig. 7 is a similar chart for operation without the damper. The boiler water dropped in temperature to about 160 F during the night period of lower room temperatures when the off- period damper was in use as shown on Fig. 6. Without the use of the damper the water temperature dropped to about 140 F. These values were checked by mercury thermometers. The heat loss involved in this 20 deg difference is not appreciable and cannot account for the saving secured with the damper. The charts show a period of 15 min to bring the water to boiling during the warming up period on days when the damper is used and about 5 min longer on days when it is not used. The efficiency during this period would be low due to cool brick work and to the necessity of bringing it up to temperature. The

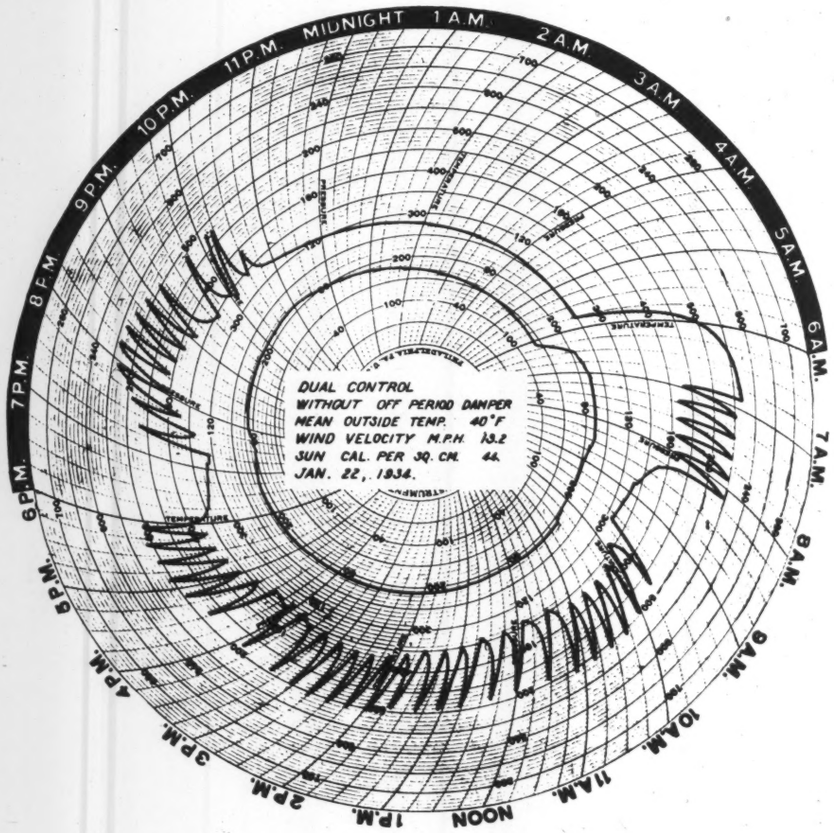

Fig. 7—Typical daily chart showing flue gas and boiler water temperatures without the use of the off-period damper

water temperature record pen led the flue gas temperature pen on this recording instrument by 15 min, to allow for the passing of the pens. The flue gas temperatures were checked with a mercury thermometer at the upper range, but are known to be too high at the lower range. It is believed that the flue gas temperature approaches very closely the water temperature during the long off period at night. When the off-period damper is used, air circulation past the thermometer bulb is stopped which affects the reading. The cooling of the boiler water after periods of operation under control of the thermostat is due not only to boiler losses, but also to the generation of steam at sub atmospheric pressures. As shown on Fig. 6 a vacuum of 10 in. mercury existed at 9 a.m. after the period of pressure controlled operation and 2 hours later when the thermostat called for additional heat, there still was a 3 in. vacuum. Since all of the material in the house has not been brought up to temperature in the warming up period of pressure control, the vacuum secured directly after this period is greater than after periods under control of the thermostat. The periods of operation under control of the thermostat, which has a built in heating coil were found to be all of about the same length and averaged about 6 min. During this 6 min period, the flue gas temperature rises. During the long initial running period early in the morning, the flue gas temperature approaches a stable value such as would be obtained on continuous operation. Fig. 6 shows 26 starts on that day and Fig. 7 shows 43 per day. The greater number in the latter case seems to be due to the greater wind velocity. On continuously maintained temperature operation, the number of starts would be greater. After each period of operation an off-period follows in which losses occur, part of which may be prevented by shutting off air circulation through the boiler at such times.

Field Survey

In the laboratory it has not been found difficult to make an installation that would result in 10 per cent CO_2 with clean burning on intermittent operation. It was possible to reduce the excess air on continuous operation and obtain considerably higher CO_2 than 10 per cent, but these same adjustments could not be maintained during intermittent operation because of the less favorable temperatures of the brick work and consequent smoking.

Previous miscellaneous tests in residence installations had indicated a wide variation in the efficiencies of combustion and heat absorption. As an example, when the oil burner was first installed in the residence on which the damper study was made, the CO_2 obtainable without smoking was 6.0 to 6.5 per cent. This was brought up to 8.0 to 8.5 per cent by various alterations up to the time of the damper study. By rebuilding of the combustion space, there is no reason why 10 per cent should not easily be secured. Since the tests made on various residence installations had indicated wide variations in efficiency, it was considered worth while to make a survey of as many residence installations as possible in order to find the variations and the average figures for present installations.

Readings were taken on 141 residence installations. Steam systems represented 78 of these, hot water systems 29, and warm air 34. Burners of 28 different manufacturers were represented some of whom had two types and Table 1 shows the distribution of burner

Table 1—Types of Burners Represented in Survey

Types	Steam	Hot Water	Warm Air	Total
H.P. Atom.	35	12	11	58
L.P. Atom.	17	5	4	26
Hor. Rotary	4	3	0	7
Vert. Rotary	15	7	6	28
Vaporizing	7	2	13	22
Totals	78	29	34	141

types among the three kinds of heating systems. The largest number made by any one manufacturer was 21 and of any one type and manufacture was 19. The average number per manufacturer was slightly less than 5.

The main items desired were the CO_2 readings indicating the extent of the loss from excess air and the flue gas temperature which while dependent to some extent on the excess air is also dependent on the rate at which the oil is being burned and the ability of the heating surface to absorb that heat. These two readings give a means of finding the largest part of the losses in the form of heat passing up the chimney. It therefore becomes possible to determine the maximum possible efficiency of the installation. The actual efficiency is somewhat less because of possible escape of hydrogen and hydrocarbons as fuel items to the chimney and radiation losses to the basement and floor. Heat loss to the basement is useful provided the basement is not overheated for the purpose for which it is intended, and some heat loss to an inside chimney helps to supply useful heat to the house. It is therefore quite possible that the unmeasured losses are offset by unmeasured gains and that the efficiency as determined by CO_2 and flue gas temperature at the boiler outlet is approximately the efficiency involved in the cost of heating.

The CO_2 determinations are shown in Table 2 tabulated as to systems and as to the number falling in each range of 1 per cent. The CO_2 was determined at the boiler outlet and in the combustion space whenever easily possible. In some installations, it was determined

Table 2—CO_2 Determinations Obtained in the Survey

% CO_2	Steam		Hot Water		Warm Air		Total	
	Comb. Space	Smoke Pipe	Comb. Space	Smoke Pipe	Comb. Space	Smoke Pipe	Comb. Space	Smoke Pipe
Below 5		5				1		6
5-6	4	12		4	1	2	5	18
6-7	6	16	4	2	3	8	13	26
7-8	7	10	2	8	4	8	13	26
8-9	4	12	3	8	1	7	8	27
9-10	5	9	1	2	1	3	7	14
10-11	11	7	1	2	2	5	14	14
11-12	4	3	1	1			5	4
12-13	3	5		1			3	6
Above 13	3						3	
Ave	9.06	7.78	7.94	7.98	7.55	7.69	8.62	7.80
No	47	79	12	28	12	34	71	141

in only one of the two locations and the number of readings is given directly below the average in each column. The average CO_2 obtained in the combustion space was 8.6 per cent in 71 installations. The average at the smoke pipe connection was 7.8 per cent in 141 installations. The CO_2 content was determined in both locations in 57 cases. The average of the CO_2 in the combustion space was 9.1 per cent and at the smoke connection was 7.4 per cent. This difference, if real, indicates the infiltration of air between the two locations. It is, however, difficult to obtain an average sample in the combustion space since mixing or combustion may not be complete at the point of sampling. A $\frac{5}{16}$ in. copper tube closed at the end and with small holes along the side was used for sampling.

Considering 10 per cent as a reasonable standard, 24 installations proved to be as good or better than might be expected. Six installations were operating with such a low excess of air that the CO_2 was 12 to 13 per cent. As great a number as were above the dividing line of 10 per cent were below 6 per cent which indicates in these cases the use of an average of about 200 per cent excess air. No attempt was made to change adjustments so that the findings represent actual residence heating conditions during average winter weather. In some cases only a change in air adjustment might improve the CO_2 determination, while in other cases the large amount of excess air is necessary due to faulty fuel preparation or lack of mixing of fuel and air at proper temperatures.

Table 3—Flue Gas Temperature Measurements Obtained in the Survey

Flue Gas Temp. °F	Steam	Hot Water	Warm Air	Total
Less Than 200				
200 - 300	1	1	2	4
300 - 400	4	1		5
400 - 500	7	4	2	13
500 - 600	12	5	6	23
600 - 700	24	9	9	42
700 - 800	29	9	15	53
Above 800	3			3
Ave Temp °F.	642.6	612	634.8	634
Number	80	29	34	143

The flue gas temperatures found on the various systems are shown in Table 3. These temperatures were taken in the smoke pipe directly beyond the connection to boiler or furnace. The reading was taken after several minutes of burner operation and is considered to be close to the average for the usual running periods of burners. The average secured for all installations observed was 634 F. Considering 500 F as a reasonable standard, 121 installations showed a higher outlet temperature than this standard and 22 a lower value.

The survey results as to CO_2 and flue gas temperatures as given in Tables 2 and 3 are shown graphically on Fig. 8. This curve sheet has been taken from a commonly quoted Government bulletin and shows total stack loss in per cent of heat value of the oil for various flue gas temperatures and CO_2 values. The survey data of individual determinations of CO_2 and flue gas temperatures have been superimposed on this as points. The average of 7.8 per cent CO_2 and 634 F indicates a stack loss of 27 per cent. The reasonable standard for an efficient installation, 10 per cent CO_2 and 500 F, indicates a loss of about 18.5 per cent. The probable maximum efficiency of the average installation observed would be 73 per cent. Other losses, such as unconsumed fuel items, radiation and conduction losses, would tend to make this lower and recovered heat from the smoke-pipe and chimney would tend to increase it. There is also a loss of heat during the off-periods that must be made up by longer running periods which therefore causes a reduction in efficiency in the production of useful heat to the rooms.

The largest loss measured was with a CO_2 of 4.6 per cent and a flue gas temperature of 780 F and amounted to 46 per cent. The smallest loss amounted to 11 per cent and was found at temperatures of less than 300 F. It is interesting to note that provided the outlet temperature is low the loss of efficiency due to low CO_2 is not serious. Sufficient heat absorption surface for the burner capacity used seems most essential.

An intermittent oil burner operates at its maximum capacity as to running time only on the coldest days of the year, and on milder days releases heat at the same rate but for fewer total hours. In hand firing the maximum rate is only used on the coldest days, consequently a lack of heating surface is only extremely serious at those times. In oil burning, it is serious at all times as the burner is releasing heat at the maximum rate. The lack of adequate heating surface is further aggravated by the tendency to adjust the burning rate in excess of the maximum heat requirements. Some of the reasons for this are: lack of knowledge of maximum heat requirements, necessity for pick-up capacity for lowered night temperatures, fitting the burning rate and brick work to the available combustion space rather than to the heating load, and the greater ease with which complete combustion can be obtained at a high burning rate than at a low rate.

As an example of the overloading of a boiler the case of a larger installation than any included in the present survey may be cited. The boiler is an 8-section square boiler originally used with hand firing of coal. When converted to oil the entire combustion space was used for oil burning which allowed the burning of about 13 gal per hour based on 3

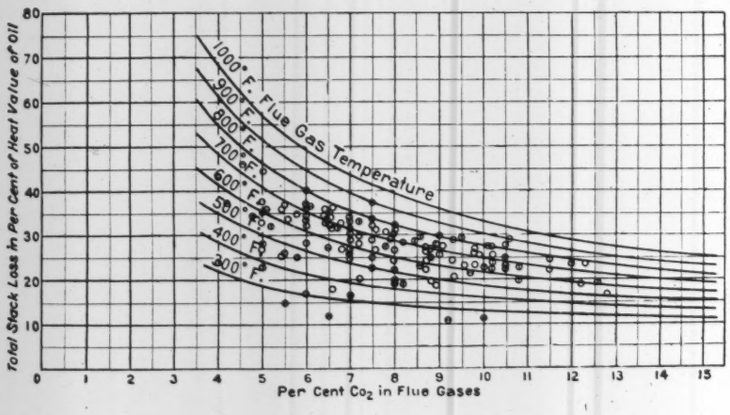

Fig. 8—Results of survey as to flue gas temperature and CO_2 superimposed on a stack loss diagram

cu ft/gal. The flue gas temperature obtained on test was 920 F after a few minutes of operation and the CO_2 was 8.5 per cent which indicates a 36 per cent stack loss during running periods. The boiler required an additional 5 sections to burn efficiently 7 gal per hour which would be ample for the heat requirements. The flue gas temperature under these conditions would probably be 450 F and the heating surface would be about 35 sq ft per gal of fuel burned per hour.

The flue gas temperatures shown in Table 3 were taken at the boiler or furnace outlet or connection to the smoke pipe. Extra heating surface commonly termed heat savers was installed in one steam system, in two hot water systems, and three warm air systems. The average drop in temperature through the heat savers was 258 F. For the three warm air systems, this drop was 365 F. The average flue gas temperature for all installations was 625 F when the temperatures taken after the heat savers in these six cases are used, as compared to an average of 634 F when the temperatures at the outlets of the boilers and furnaces are used in all cases. The values on Fig. 8 are those obtained at the boiler or furnace smoke connection. In one case with added heat absorption surface the loss to the chimney was 10 per cent, one per cent lower than the loss quoted in connection with Fig. 8.

Table 4—Division of Determinations of Flue Gas Temperatures and CO_2 As to Age of Installation

	Steam	Hot Water	Warm Air	Weighted Ave
3 Yrs. or Less				
Flue Gas temp	650	620	615	635
CO_2	7.5	7.7	7.9	7.7
No. Installations	45	14	24	83
Older Than 3 Yrs.				
Flue Gas temp	635	600	680	633
CO_2	8.2	8.2	7.5	8.0
No. Installations	32	15	9	56

Table 5—Draft Readings Obtained in the Smoke Pipe and in the Combustion Space

Draft Inches of Water	Steam		Hot Water		Warm Air		Total	
	Front	Rear	Front	Rear	Front	Rear	Front	Rear
Below 0.02	6	3	1	1	–	–	7	4
0.02 - 0.05	26	10	7	5	5	6	38	21
0.05 - 0.10	11	27	2	14	5	18	18	59
0.10 - 0.15	4	19	1	4	2	8	7	31
Above 0.15	1	15	–	1	–	2	1	18
	.0448	.111	.04	.07	.06	.086	.0468	.0965
	48	74	11	25	12	34	71	133

Table 6—Tabulation of Methods of Supplying Domestic Hot Water

Types	Steam	Hot Water	Warm Air	Total
Fire Coil	8	9	18	35
Gas	14	10	13	37
Coal	2	0	0	2
Indirect	36	4	0	40
Oil	6	3	1	10
None	8	2	2	12
Total	74	28	34	136

Table 4 shows a summary of the survey results as to CO_2 and flue gas temperature separated as to installations made in the three years before the survey and those made previous to that time. For the newer installations the flue gas temperature averaged 635 F and the CO_2 7.7 per cent. These values for the older installations were 633 F and 8.0 per cent. The separation was based on the time of burner installation. In some cases this coincides with the time of the heating plant installation and in other cases the burner was placed in an older heating plant. The results indicate no great change in the efficiency of the newer installations.

The averages of 7 boiler-burner units recently installed were found to be 529 F flue gas temperature and 9.3 per cent CO_2. Two installations of one manufacturer showed an average flue gas temperature of 445 F and 7.2 CO_2, and four of another manufacturer showed an average of 629 F and 11.3 per cent CO_2. In each case this corresponds to about a 21 per cent stack loss.

The draft readings obtained in the combustion space and at the smoke pipe connection are shown in Table 5. The draft loss through 12 warm air plants where the draft was observed at the two locations averaged 0.026 in. H_2O. In 43 steam plants the draft loss was 0.042 in. H_2O and in 8 hot water plants was found to be 0.037 in. H_2O. Usually a high reading in the combustion space would be associated with a low CO_2 reading. The particular weather conditions at the time of taking the reading affect the draft especially if a draft regulator is not installed. Eighty-five installations had draft regulators and 56 were without these useful devices.

The number of installations having some means of humidification was 63 as against 70 without any such means. In warm air plants, two out of 33 had no humidification method, in hot water plants 13 out of 23, and in steam plants 55 out of 77 had no means of supplying moisture to the air. Table 6 shows the means of supplying hot water for tap use. Seventeen boiler installations used coils in the combustion space as com-

Table 7—Tabulation of Fuel Costs on a Room and Square Foot of Floor Space Basis

	Steam		Hot Water		Warm Air		All Systems	
	Oil	Solid fuel	Oil	Solid fuel	Oil	Solid fuel	Oil	Solid fuel
No of Systems with Comparative Cost Data	24	24	11	11	17	17	52	52
Ave. Cost per Sq. Ft. of Floor - Cents per Yr.	8.26	8.13	7.56	7.37	7.11	8.81	7.74	8.18
No. of Systems with Cost Data	55	28	19	11	26	23	100	62
Ave Cost per Sq. Ft. of Floor - Cents per yr.	8.35	8.23	7.23	7.37	7.07	8.82	7.82	8.30
Minimum Cost Cents per Sq Ft. per yr.	4.24	3.5	4.5	4.5	4.1	3.1	4.1	3.1
Maximum Cost Cents per Sq. Ft. per yr.	15.2	13.8	10.70	10.4	11.8	14.5	15.2	14.5
No of Systems with Comparative Cost Data	24	24	10	10	18	18	52	52
Ave. Cost Dollars per Room per yr.	16.80	16.21	16.03	15.96	14.69	17.42	15.93	16.58
No. of Systems with Cost Data	50	28	20	10	27	21	97	59
Ave. Cost Dollars per Room per yr.	18.75	16.48	15.11	15.96	14.38	17.17	16.78	16.63
Minimum Cost Dollars per Room per yr.	9.60	10.70	7.00	10.50	11.20	9.00	7.00	9.00
Maximum Cost Dollars per Room per yr.	33.90	32.00	22.50	26.50	20.00	30.00	33.90	32.00

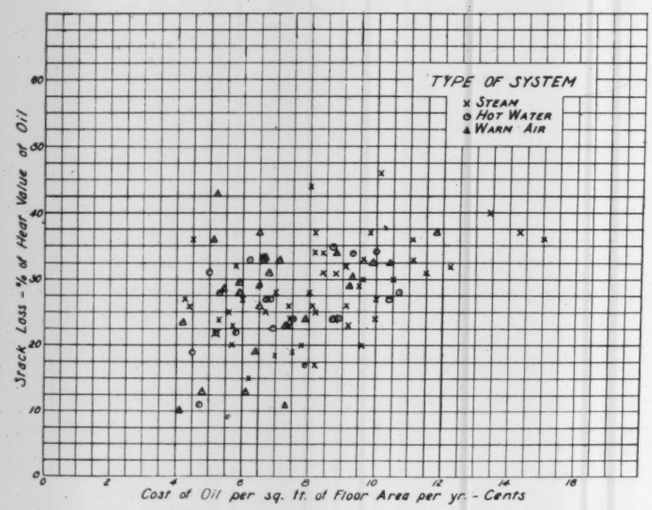

Fig. 9—Relation between the cost of oil for heating and the measured stack loss

pared to 40 using indirect heaters with boiler water as the heating medium.

Yearly costs of heating were obtained in all cases where the owners had kept careful records and in many cases these were checked with fuel companies' records of deliveries. Twenty-seven reported savings which averaged 29 per cent with the changing from hand-fired solid fuel to oil burning. Sixteen reported the same cost with the two methods of heating and 16 reported an increased cost of 23 per cent with the change from solid fuel to oil burning. In some of the cases where savings were obtained a new boiler, furnace or heat saver was installed at the time of change.

Table 7 presents the cost data on a basis of each square foot of floor space in occupied rooms and also on a basis of cost per room. Since types of construction vary greatly, the cost on either of these bases would vary considerably, even should the efficiency of the heating plant be the same in every instance. The data are shown in two ways: for only the installations in which records were obtained for the two types of fuel and for all cases where cost records were obtained. In many instances the original installation was arranged for oil burning and therefore no comparison was available.

Based on 52 installations the cost per square foot of floor space per year with oil heating was 7.7 cents and with solid fuel 8.2 cents. The cost per room per year with oil burning figured out as $15.93 and with coal $16.58 for cases reporting costs for both fuels. These costs of course depend upon the unit price of fuel during the years involved. The oil burning period of years was immediately previous to the time of the survey and the solid fuel burning previous to this variable number of years. It is, therefore, very difficult to know the unit prices of the fuels involved[2]. The figures when placed on the room basis are subject to the variations of room sizes in various types of houses. This accounts for some of the variation in costs per room which varied from $7.00 to $33.90 with oil burning and from $9.00 to $32.00 with hand-fired solid fuel. The average cost of oil heating was $16.78 for the 97 cases in which oil burning costs were obtained on a room basis.

In 59 cases where solid fuel costs were given, the average cost per room was $16.63. Since the same installations are not involved in the two sides of this comparison, the size of the rooms involved would influence the results. On a square foot of floor area basis, the costs were 7.8 cents per year for oil in 100 cases as compared to 8.3 cents per year for 62 cases with solid fuel which check very closely with the figures also given in Table 7 for the 52 cases in which oil and solid fuel costs were given for the same installations.

On Fig. 9 are plotted the points representing the cost of heating with oil and the measured stack loss. These measured stack losses were obtained from Fig. 8 by the use of the CO_2 and flue gas temperature readings for each installation in which oil heating costs were known. There would be a minimum cost of heating for every house construction even with complete utilization of the entire heating value of the oil. With a given construction the greater the stack loss the higher the cost of heating. In general the distribution of points indicates that usually a high stack loss means a high cost of heating. That a few points indicate low costs of heating in spite of a high stack loss is understandable by several reasons. The efficiency of oil burning might have been poorer at the time of test than over the period of years in which the yearly oil costs were taken. The economy of heating might be secured in certain cases by under heating parts of the house. The house may have been well insulated so that the heat losses were low or the losses may have been largely recovered as useful heat from the smoke-pipe and chimney.

Conclusions or Summary

A study of the losses during off-periods of oil burner operation on a laboratory set up indicated that a saving of 9 per cent resulted from the prevention of air circulation through the combustion space during these periods. This saving was found at about one-third load with the oil burner adjusted to run continuously when carrying full rating.

A similar study in a residence indicated under fairly average heating conditions for the locality an 8.9 per cent saving with an automatic off-period damper with a continuously maintained room temperature of 70 F although unequal sun intensities probably make this figure slightly high. With lowered night temperatures, the saving found due to the off-period damper was 7.2 per cent. This is considered low because the damper was controlled by the room thermostat and remained open during the off-periods of the warming up period. It is believed that the saving has some direct relation to the number of starts and accordingly the saving in connection with dual temperature operation would be less than with continuous room temperatures.

The off-period loss and therefore the saving possible with the use of an off-period damper depends on many variables, some of which are: the heat capacity of the brick work, the length and frequency of running periods, adjustment of the draft as to intensity, and

[2]The average prices per ton for solid fuels in Madison for the 4 years 1929 to 1933 were as follows: Illinois bituminous, $8.44, semi-bituminous egg size, $11.94, coke, $12.25, anthracite pea and nut, $15.94; the arithmetical average of these is $12.14. The average prices per gallon for domestic grades of fuel oil in Madison for the 4 years 1930 to 1934 were as follows: No. 1—7.3c, No. 2—6.5c, No. 3—6.4c, and No. 4—6.1c; the arithmetical average of these is 6.6c.

the resistance to gravity air flow of the air supply path and of the heat absorption passes. The savings reported in this paper although applying strictly to the installations tested are considered to be an indication of the savings possible in somewhat better than average installations. Where conditions are less favorable to efficiency the use of the damper would result in a greater saving. The question of safety arising in the need for ventilation of the combustion space during off-periods to clear it of combustible gases has not been studied. This question requires considerable attention before off-period dampers might be used generally in residence oil burning.

A survey of some 140 residence installations indicated a stack loss of 27 per cent as determined by a CO_2 average of 7.8 per cent and an average flue gas temperature of 634 F. The presence of unburned fuel items in the flue gases was not determined and if present would increase the above loss. The recovery of heat loss by conduction or radiation from the heating plant, such as from the boiler, smoke-pipe or chimney would increase the efficiency above that indicated by the above loss.

A wide variation in stack losses was found indicating that many installations may be rated as excellent and others as unacceptably poor. The largest loss found in the survey was 46 per cent and the smallest was 10 to 11 per cent. A separation into installations made during the three years previous to the survey and those made previous to that time indicates no improvement in the average efficiency.

An analysis of costs of oil heating on a unit floor area basis indicates a relation between cost of fuel and efficiency as shown by CO_2 and flue gas temperatures. A reasonable although arbitrary standard for an efficient installation would appear to be 500 F and 10 per cent CO_2 without smoking, which corresponds to a stack loss of 18.5 per cent.

Michigan

May 15, 1935. Approximately 40 members and guests attended the annual meeting of the Michigan Chapter, which included a business meeting and golf tournament.

Pres. G. D. Winans opened the meeting by having Secy. W. F. Arnoldy read the minutes of the previous session, as well as some correspondence from headquarters office regarding the Semi-Annual Meeting of the Society in Toronto.

In a report of the Nominating Committee, which was composed of J. F. McIntire, Chairman, H. E. Paetz and R. S. M. Wilde, nominations for officers for the coming year were submitted.

President—A. C. Wallich
Vice-President—R. K. Milward
Secretary—W. F. Arnoldy
Treasurer—F. J. Feely.

The following members, of whom three were to be elected, were also nominated for the Board of Governors: A. P. Darlington, Edward Glanz, R. F. Connell, W. H. Baldwin, J. S. Kilner and G. H. Cummins.

There were no further nominations from the floor, and it was moved and seconded that the nominations be closed, and that the Secretary cast a unanimous ballot for the nominees for President, Vice-President, Secretary and Treasurer.

Ballots were then distributed for voting for the three members of the Board of Governors and resulted in the election of R. F. Connell, Edward Glanz and A. P. Darlington.

At the end of the business meeting the Golf Committee, consisting of Frank Feeley, E. Anderson, and H. E. Paetz, distributed awards to E. Anderson for low gross, R. L. Spitzley for attendance, and to F. Scherger, A. C. Wallich, R. L. Wells, Earl Sheely, A. T. Paetz, W. F. Arnoldy, F. Hollock, A. Emrick and C. Gudnau, who took honors in the Kicker's Handicap.

The meeting adjourned at 9:45 p. m.

Pacific Northwest

May 28, 1935. The final spring meeting of the Pacific Northwest Chapter was held at the Hungerford Hotel with Pres. A. L. Pollard presiding and 20 members and guests present. The minutes of the April meeting were read and approved.

Results of the election of officers were announced and the following were installed for the year 1935-1936:

President—Lincoln Bouillon
Vice-President—S. D. Peterson
Secretary—D. C. Griffin
Treasurer—W. W. Cox

The first guest speaker was L. L. Finnigan and his discussion covered the outstanding features of an automatic fuel oil burner, which utilizes for ignition the principles employed in oil refining.

The second speaker of the evening was J. J. Hourigan, who gave a very interesting description of equipment used and experiences in the air conditioning of railway cars, in the control of both heating and cooling loads. An enlightening discussion followed, as everyone present displayed a great deal of interest in this comparatively new field.

The meeting adjourned at 10:00 p. m., according to the report of Secretary Griffin.

Pittsburgh

May 13, 1935. Members of the Pittsburgh Chapter were the guests of the Pittsburgh Testing Laboratory at a private inspection and buffet supper.

At 9:00 p.m. Pres. L. B. Pittock called the members together for a short business session and the reading of the minutes of the April meeting was dispensed with because of the late hour.

Committee reports were in order and J. F. Collins, Jr., of the Program Committee announced that the next regular meeting would be held in October.

E. C. Smyers reported that 13 members had affiliated with the A.S.H.V.E. since January 1, 1935.

A report on a recent meeting of the *Affiliated Technical Societies* was given by R. B. Stanger, who represented the Pittsburgh Chapter.

Secy. T. F. Rockwell read several letters from headquarters office, relating in part to the Semi-Annual Meeting of the Society in Toronto.

G. S. McEllroy stated that the committee had prepared its final report on the proposed ventilation code and was awaiting comment from the Philadelphia Chapter.

A proposed amendment to the Society's Constitution and By-Laws in regard to the qualifications of Student Members was presented by Prof. C. M. Humphreys, and it was moved and carried that the Pittsburgh Chapter was in favor of the amendment presented.

A motion was made and carried that President Pittock appoint a committee to study weather data which may affect the need for heating and to coordinate these data to provide a uniform basis for determining heating requirements. President Pittock immediately appointed the following committee to confer with W. S. Brotzman, head of the Pittsburgh Weather Bureau: F. A. Gunther, Chairman, F. C. Houghten, and J. F. Collins, Jr.

The meeting adjourned at 9:30 p.m.

Cooling and Air Conditioning in an Ale Brewery

By **C. P. Creighton*** ***(NON-MEMBER)*** **and F. J. Friedman*** ***(MEMBER)***
Montreal, Que., Can.

THE purpose of this paper is to describe the methods adopted in the design of the cooling and air-conditioning equipment for the fermenting room of an ale brewery and also to describe certain constructional features of the installation, which it is believed will be of interest. Ventilating and air conditioning problems in other parts of the plant will be touched on with the idea of indicating their scope, rather than with any intention of giving complete descriptions or discussion.

The fermenting room of an ale brewery is undoubtedly the department in which an adequate cooling and ventilating system is most important. Other departments such as the wort cooler room and storage rooms also offer their problems but these are of minor importance when compared to the fermenting room. This paper will treat principally of the fermenting rooms of Molson's Brewery, Montreal, the methods of conditioning of which it is believed offer several points of interest.

It has been found in breweries with which the authors are familiar that even temperature and humidity in the fermenting room tend to greater uniformity of product both as to quality, flavour, and rate of fermentation. The clean filtered air lessens the danger of contamination of the brew by air borne wild yeast cultures, mould spores, or other organisms, while the dryer air of the room lessens the condensation on walls and other apparatus with consequent reduction in mould growths. The lessening of condensation on walls, etc., also permits a considerable saving in maintenance of the building due to the greater life of paint work and reduced necessity of frequent scrubbing and disinfecting.

In the winter, when heating is required with consequent necessity of added humidity in the air, the drying-out of empty tuns is retarded and yeast remains in a much healthier condition.

There are 5 fermenting rooms in the brewery being considered, 4 of which are air-conditioned. These rooms are of the following sizes:—

Room *A*	44 ft	× 36 ft	× 18 ft
Room *B*	175 "	× 37 "	× 18 "
Room *C*	122 "	× 38 "	× 18 "
Room *D*	122 "	× 38 "	× 18 "

Each room contains 2 rows of fermenting tuns, 1 row along each wall. The rooms are partially divided into 2 levels by a gallery 9 ft from the floor through which the tuns project. This gallery has an opening 8 ft wide in the center and extending the entire length of the room. Fig. 1 shows a typical cross section of these rooms.

The heat loss in winter and heat gain in summer, due to outside conditions, were calculated in the conventional manner, the only rather unusual feature being the very large number of factors for heat transmission through building construction owing to the number of different types of walls and their varying ages and conditions. Parts of the buildings are over 100 years old and numerous alterations and additions have been made since the original construction, so that it was necessary in most cases to drill the walls to determine their character and condition.

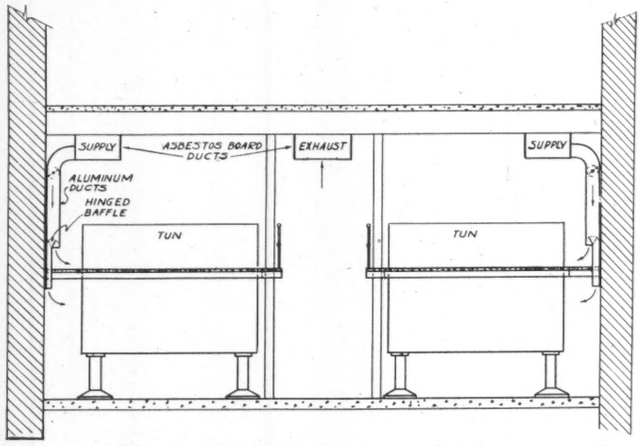

Fig. 1—Section through fermenting room

Wall transmission factors were calculated according to the methods recommended in THE A. S. H. V. E. GUIDE and, while the calculations were somewhat laborious, due to the large number of types of construction used in different parts of the walls, floors and ceilings, and also to the very different temperatures obtaining in adjacent rooms or the outside at different seasons of the year, the method involved no departure from standard practice. Separate calculations were made to determine heat losses or gains in both winter and summer. In one room particularly—Room *A*—these quantities practically balanced at all times since the heat lost or gained through outside walls or from adjacent warm rooms was almost equal in most cases to that lost to adjacent cold rooms. The rooms were all well insulated with corkboard and were provided with gasketted refrigerator doors and triple glass windows.

*McDougall & Friedman, Consulting Engrs., Montreal, Can., and New York, N. Y.

Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Toronto, Ont., Can., June 1935.

The Btu losses or gains per hour due to wall transmission, but not including ventilation or process requirements, were:—

	Heat Loss Winter	Heat Gain Summer
Room *B*	48,000 Btu	68,600 Btu
Room *C*	23,800 Btu	10,229 Btu
Room *D*	39,000 Btu	20,900 Btu

The rooms were all figured for the same inside and outside conditions. Inside temperatures were to be maintained at 55 F with a relative humidity of 70 per cent to 75 per cent. Outdoor conditions were assumed as—20 F in winter, and 90 F and a relative humidity of 70 per cent in summer. The design of the whole plant made provision for the introduction at all seasons of a maximum of 2500 cu ft of outside air per minute for ventilation. The fans and duct work were designed to recirculate 28,000 cu ft of air per minute.

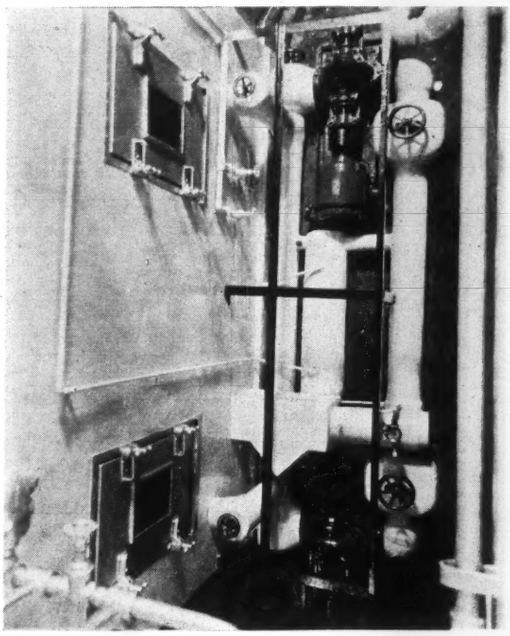

Fig. 2—Front of dehumidifier looking down

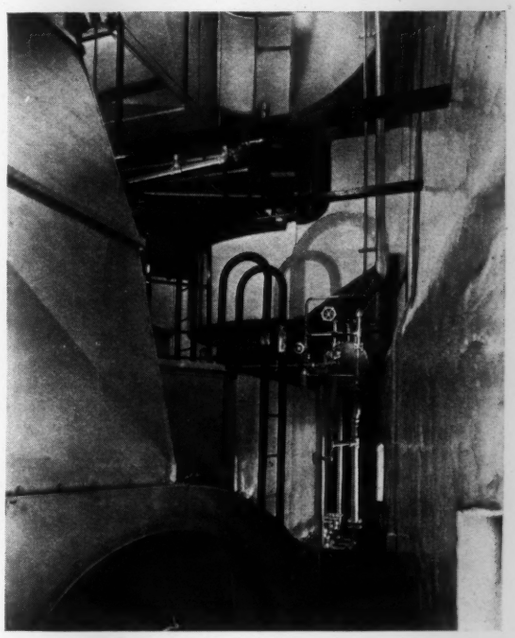

Fig. 3—Rear of dehumidifier showing ammonia connections

The indoor conditions of an ale brewery are somewhat different from those usually maintained in lager beer breweries where fermenting room temperatures are usually around 40 F and indoor humidity can also be kept lower owing to the general use of closed steel fermenters. Ventilating requirements of such plants are also reduced as the carbon dioxide gas produced in the process is conducted by pipes to a point outside the fermenting room.

The heating and cooling and ventilating requirements to take care of conditions due to the process of fermentation were more difficult to determine, the data available being rather meagre and the conditions varying in each individual plant due to differences in the methods of fermentation used.

During the process of fermentation, sugars in the wort or unfermented ale are acted on by the yeast and converted to alcohols and carbon dioxide gas with consequent production of heat. Most of this heat is carried off by cold water circulating in copper coils inside the fermenting tuns. There is, however, a certain amount of heat and moisture thrown off from the surface of the fermenting ale. There is also a large amount of carbon dioxide gas produced, this gas flowing over the edge of the tuns into the room. The rate of fermentation is controlled throughout the process by varying the temperature so that heat and gas are produced at a varying rate at different periods throughout each brew. The rate of production of heat was calculated from the known rate of change of sugar into alcohol and gas and the amount of heat carried away by the cooling water measured and deducted. The difference was assumed to be the heat lost to the air of the room either by convection or the evaporation of moisture. Actual figures are not quoted for this calculation, as they involve private information as to temperatures and rates of fermentation which have an important bearing on the quality and flavour of the ale and which are in the nature of trade secrets for each plant where such a system might be installed.

Owing to the scrupulous cleanliness in these rooms, a large amount of washing is done involving a large moisture pick-up from wet walls, floors and tuns. This amount could only be estimated from experience in similar installations and would have to be estimated with a view to actual conditions.

The production of carbon dioxide gas during fermentation was calculated in a manner similar to that indicated for the production of heat and was also built up step by step for successive brews. Owing to the steady orderly production of the gas, the concentration near the floor was found to be very high, sometimes reaching 5 per cent to 6 per cent at heights of 6 in. or less, although decreasing 2 per cent to 3 per cent at the breathing line. By taking advantage of this condition and exhausting air from the rooms at very low

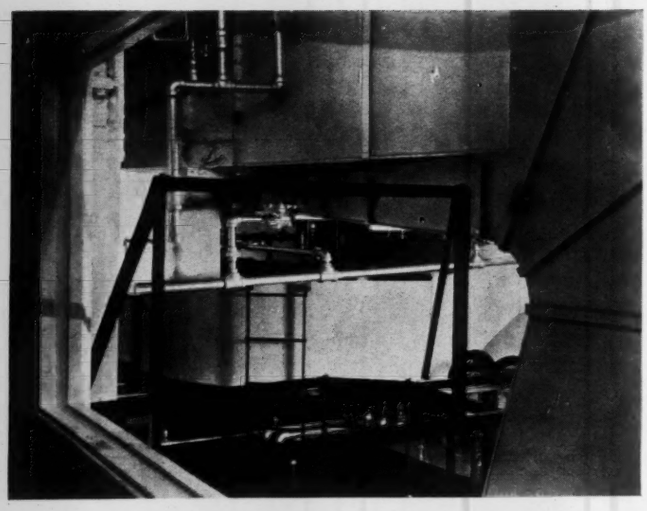

Fig. 4—Ducts and heaters in top of apparatus room

levels while recirculating air from a point near the ceiling, the amount of air from outside necessary for ventilation was greatly reduced with consequent saving of heat and refrigeration.

After considering the various methods of cooling, such as unit coolers, three central plants, or a single central plant, the latter alternative was adopted.

The conditioning equipment consists of duplicate circulating fans; dehumidifier unit with by-pass ammonia cooling coils, water sprays, and duplicate water circulating pumps; preheater in fresh air inlet, filter in fresh air inlet, reheaters in supplies to each room, and automatic control thermostats, dampers and diaphragm valves. All this apparatus is located in a suction chamber to which all return ducts are brought. The suction chamber is brilliantly lighted and has large glass windows for observation and display, all apparatus being finished in white enamel. Figs. 2, 3 and 4 show general views of apparatus in this room.

Fig. 6—Main exhaust trunk

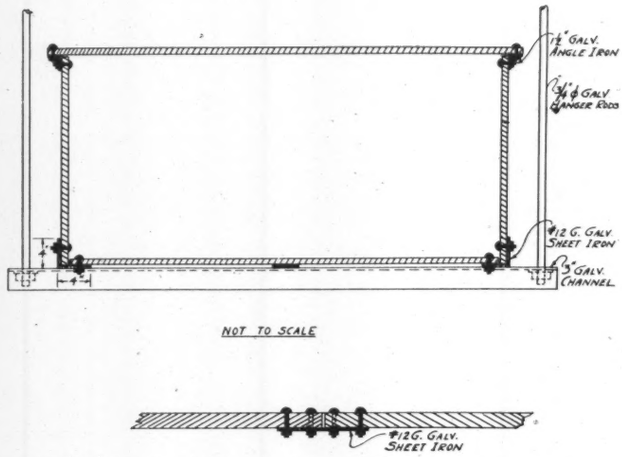

Fig. 5—Detail of fibre duct construction and of cross joints

Temperature of air delivered from the dehumidifier is controlled by a thermostat in the return duct from Room *B*, this room being the one requiring the greatest temperature differential between supply and return when cooling, and the least when heating. Individual reheaters in the ducts supplying *C* and *D* are controlled by thermostats on the return ducts from these rooms. The reheaters also serve as heaters for the rooms in the winter. Fig. 9 shows a diagram of the dehumidifier, fans and heaters.

No separate fresh air fan is provided, the duct being connected to the inlet of the dehumidifier and the quantity being kept constant by a velocitystat located in the inlet and controlling the suction on the dehumidifier. Dry type filters are used to clean this air before entering the sprays.

The duct work presents several unusual features. Owing to the fact that the system had to be installed in an existing building, it was impossible to provide for the concealment of ducts. It was, therefore, necessary to run ducts on the ceilings of rooms over the top of fermenting tuns. It was considered that there was danger under certain conditions of ducts sweating and dripping into these open tuns with the possibility of contamination of the product which might possibly ruin a brew and as the raw material is of considerable value

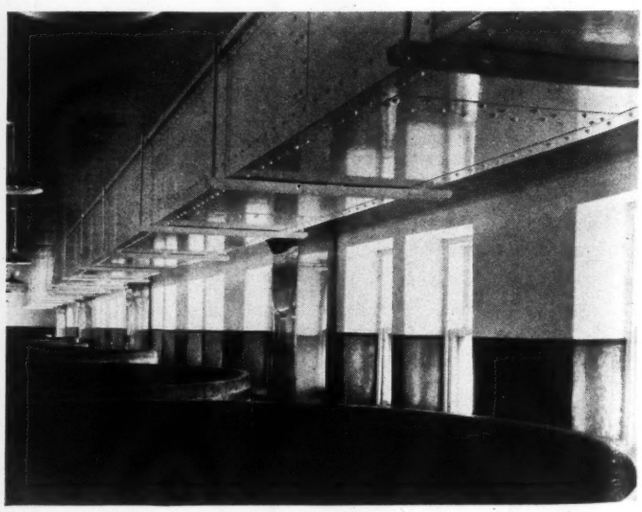

Fig. 7—Main supply trunk showing aluminum supply drops

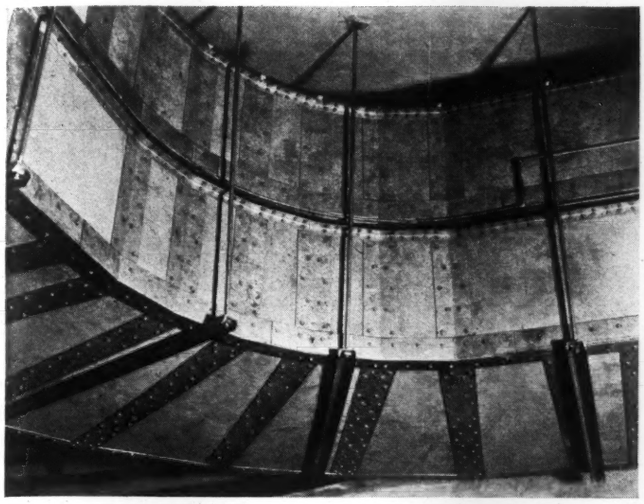

Fig. 8—Detail of asbestos board duct elbow

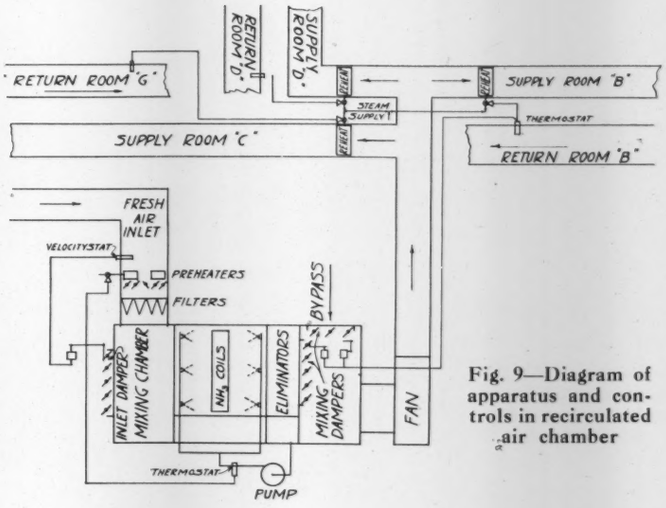

Fig. 9—Diagram of apparatus and controls in recirculated air chamber

and as such contamination might also cause great inconvenience, it was decided to build all such exposed ducts of insulating material. A composite material consisting of 2¼-in. layers of hard asbestos board with ½ in. of wood fibre board between was chosen. These sheets were fastened together with galvanized angles, strips, and bolts as shown in Fig. 5. All main ducts, vertical and horizontal were made large enough for a man to crawl through for cleaning. Vertical supply drops exposed in the room were constructed of polished #14 gage aluminum. Large vertical ducts were fitted with permanent steel ladders inside to aid in cleaning and vertical supply drops arranged so that a long handle brush could be pushed up from the bottom. Air distribution was controlled by numerous volume dampers rather than by duct sizes as the dimensions necessary for cleaning were often much larger than necessary for the quantity of air. In addition, duct sizes were chosen so that standard sheets of the insulating board could be cut without waste. Figs. 6, 7 and 8 show general and detail views of the duct work. The cost of this duct work was about double that of sheet metal, though little if any greater than the cost of metal duct covered with insulating material.

Other departments of the brewery, principally the hot wort cooler room, storage cellars and bottling shops, offer a field for air conditioning with or without cooling.

In the hot wort cooler room it is the usual practice to run the hot liquid over the pipes of a Baudelot type cooler. This serves the dual purpose of cooling and aerating the wort. Since the liquid is at boiling temperature when it flows on to the cooler, a large amount of vapor is released necessitating powerful supply and exhaust fans for its removal. The supply air should be filtered to prevent contamination of the wort by dust, wild yeast or bacteria. Care must also be taken to keep only a very slight plenum in the room in order to avoid driving moisture into the building construction. Heaters for this air, preferably thermostatically controlled, are desirable in order to reduce fog in the room and to dry up condensation on the walls.

The storage cellars and hop storages also offer a field, though less extensive, for air conditioning. The reasons for this are very similar to those already cited for the fermenting rooms, namely uniformity of conditions for aging and storage, prevention of sweating of walls and apparatus with consequent greater cleanliness and ease of maintenance. Bottle shops and other such departments present only conventional ventilation problems of heating in winter, and the removal of heat and vapor in summer.

The authors regret that it is impossible to present accurate operating data concerning the fermenting room installation described above, as complete experience extends over the winter months only and there has been no weather as yet suitable for a complete test on the cooling operation. The authors hope, however, to present such operating data to the Society at some future date. Winter operation results were very satisfactory, the apparatus being easily capable of maintaining the designed inside temperature and relative humidity as low as 55 per cent if desired. Heat losses checked by the quantity and temperature of air delivered and recirculated from the rooms checked very closely with the design figures.

Standards for Drawings and Drafting Room Practice

The desire for a national standard of engineering drawings over a period of years has been fulfilled by the issuance of the American Standard for Drawings and Drafting Room Practice approved by the *American Standards Association* in May, 1935.

For many years the larger drafting rooms have devised their own standard practices, and graphical symbols in unnecessary variety were developed, resulting in great inconvenience and loss of time to the draftsman and designer. The standard in general follows the prevailing present practice as indicated by the majority of votes on the questionnaires and approvals of preliminary reports by the committee.

The items covered in this standardization of American practice include the arrangement of views, lines and line work, sectional views, dimensioning, screw thread representation for bolts and threaded parts, sheet sizes and lettering. The pamphlet contains many graphical drawings and symbols to amplify the text material. Copies may be obtained from the *American Standards Association*, 29 West 39th St., New York, N. Y., at a cost of 50c each.

Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS is located

Classroom Drafts in Relation to Entering Air Stream Temperature

By **F. C. Houghten* *(MEMBER)*, H. H. Trimble,* * Carl Gutberlet,*** and Merle F. Lichtenfels,† *(NON-MEMBERS)***

Pittsburgh, Pa.

THE relation between the temperature of the air supplied to classrooms and drafts experienced by occupants has received considerable attention by engineers and others interested in school ventilation. Many suggestions have been made for limiting the minimum temperature of the entering air stream. However, there is no unanimity of opinion fixing the limiting value or specifying if the limiting temperature should vary with the volume, velocity, location and direction of the entering air stream.

The study of the relation between drafts and air stream characteristics was recently given to the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS under the guidance of the Technical Advisory Committee on Minimum Temperature and Method of Introduction of Cooling Air in Classrooms. The Pennsylvania School Heating and Ventilating Commission, in developing a proposed code for regulating the installation of heating and ventilating equipment in schools in the State, recognized the problem. While in their code a limiting value of 55 F was specified for an air stream directed upwards and 60 F for an air stream projected horizontally into the room, the question was recognized as a controversial one and was listed by the Commission with other subjects needing further study.

There is no accepted definition available specifying just what constitutes a draft. In general, a draft is accepted as a condition within an occupied space resulting in local chilling of some parts of the body surfaces of the occupants. While the term is generally associated with, and is derived from air movement, any condition of the atmosphere or surroundings which results in local chilling is generally called a draft. If this interpretation is accepted, then a draft may result from a local, low air temperature area within an occupied space, the movement of air against the body so as to give a local chilling effect, or radiation from a part of the body to cold walls or other cold surfaces, or any combination of these three effects. It is doubtful if a person can distinguish between local chilling of a portion of the body surface by any of these three causes.

The study was carried on by the Research Laboratory during the last half of the past heating season, in the Woodlawn Avenue School of Munhall, Pa. A few additional observations were made late in the heating season in the Shaler Township High School, near Pittsburgh. The Woodlawn Avenue School is modern and contains 20 classrooms and the usual arrangement of auditorium, gymnasium, and other space devoted to group activities. Each classroom in this school is heated

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and ventilated by auxiliary radiators and a unit ventilator. In most rooms the unit ventilator is under a window in the center of the outside wall as shown in Figs. 1 and 2. In these rooms two direct cast-iron radiators are located under windows, one at either side of the unit. In a few of the rooms the unit is located at one side, and a single auxiliary radiator at the other side of the center of the room.

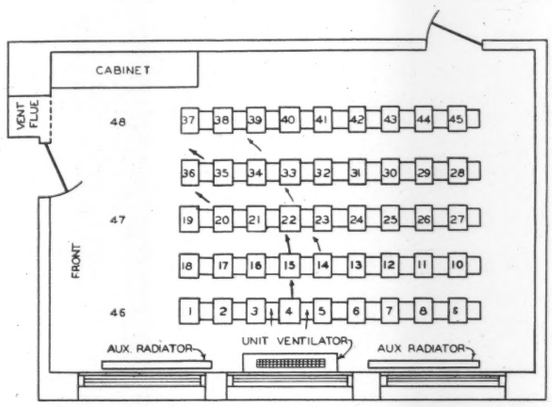


Fig. 1—Plan view of Room 301 and prevailing air streams, showing observation station numbers used in all tests

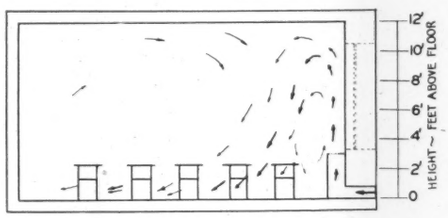


Fig. 2—Vertical section of Room 301 showing prevailing vertical air stream

The room temperature is maintained by thermostatic control so arranged as to, first, cut off the steam supply to the auxiliary radiators, and later, to open the by-pass damper, around the heating unit within the unit ventilator, in order to avoid overheating. The units are equipped with dampers controlled from the janitor's quarters in the basement, allowing all units in the building either to take in all outside air or to recirculate room air entirely. Each unit ventilator is wired for low, intermediate and high speed operation, any one of which can be selected by a switch. In the normal operation of the building the units are always operated at low speed during the heating season, giving an average air velocity of approximately 500 fpm, and an average air supply of approximately 1200 cfm, calculated from the outlet velocity and grille area. They are only run at intermediate or high speed during mild weather, when greater air volume is needed to avoid overheating. All room are provided with room vent flues.

Classrooms in this school are approximately 22 ft wide from the corridor to the exposed wall, and vary from 28 ft to 46 ft, 10 in. in length. Very few of the corner rooms have a second outside exposure, since most of this space is devoted to stairways and other purposes. In no case did a room have a second exposure containing a window. Additional characteristics of the rooms and operation of the units are given in an earlier Laboratory report[1].

A few observations were made late in the heating season in a room equipped with a late model unit ventilator built by the same manufacturer. Besides having the features mentioned above for the earlier models, it was equipped with a thermostatic element in the outlet air stream which actuated the steam supply valve to the heater within the unit. This gave greater ease of control of the inlet temperature during a test. The new model gave a higher outlet velocity, but since the grille opening was smaller, the volume of air delivery was not very different.

A few tests were also made in the Shaler Township High School, near Pittsburgh, where rooms equipped with unit ventilators made by a different manufacturer were studied. These units operated about the same as those installed in the Woodlawn school, the only difference being that the discharge grille was set at an angle of about 10 deg with the horizontal, and the unit had no means for speed control except by changes in the wiring.

Most observations were made with normal room occupancy and with the heating and ventilating system operating in accordance with usual practice in this school. In order to avoid having the thermostat change conditions during a survey, means were made available whereby the steam supply to the auxiliary radiators could be controlled by hand operation. Also in some tests, in order to insure continuous operation under the same conditions for a sufficiently long period, the by-pass damper was blocked in the desired position and the steam supply to the auxiliary radiators was controlled by hand. Results obtained under unusual operation of the system were checked by similar tests with normal thermostatic operation whenever possible.

[1]Air Supply to Classrooms in Relation to Vent Flue Openings, by F. C. Houghten, Carl Gutberlet and M. F. Lichtenfels, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning*, June, 1935.

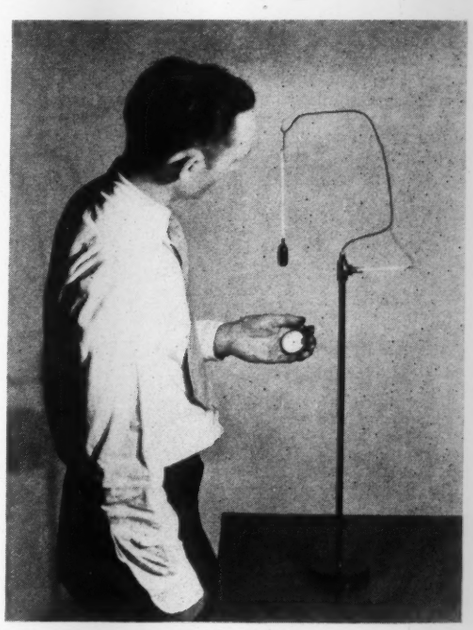


Fig. 3—Making observations of Kata cooling rate and dry-bulb temperature

The procedure followed during a survey in any room was to maintain the desired temperature in those portions of the room unaffected by drafts while Kata thermometer and dry-bulb temperature readings were made throughout the room. For this purpose, 12 of the standards shown in Fig. 3 were placed on the desks, seats, or the floor of the room. A few strands of silk floss attached to the standards served to give an immediate visual indication of the locations of points of considerable air movement. Actually, the silk floss proved to more sensitive than necessary, since it indicated air movements as low as 5 or 10 fpm. Greater velocities gave more violent movement of the floss. Sensitive thermometers were also attached to the standards.

Kata thermometer observations were then made at the points of more violent air motion by hanging the instruments on the standards and simultaneously observing the air temperatures and Kata cooling rates. The Kata cooling rate and the constant for the instrument gives the Kata cooling power directly, or these values and the dry-bulb temperature of the air at the same point gave the air velocity. The dry Kata cooling power in millicalories per square centimeter per second is given for a range of temperatures and air velocities in Table 1.

Simultaneous observations of air temperature throughout the room were made. The observers also made observations of the draft sensation they experienced while seated in the locations in which various air temperatures and velocities, or dry Kata cooling powers, were observed. In some instances the sensations observed at these points by the children and teachers were also recorded.

Since only two Kata thermometers were available for the study, and since an average of 3 min was required for making a single observation, complete simultaneous surveys of air movements were not possible, but had to be extended over a considerable period of time.

The plan view of a typical classroom, 301, shown in Fig. 1, gives the location at which observations were made. The results of three partial surveys made in this room on three different days, when the incoming air temperature ranged from 37.5 F to 40 F, are given in Table 2. The temperature, air movement (calculated from the dry Kata thermometer observations), and the Kata cooling power for several of the stations shown in Fig. 1 and for elevations of 6, 18, 35 and 45 in. above the floor are given. The prevailing air currents observed in these surveys are shown by arrows in the plan and vertical views of the room, Figs. 1 and 2. It will be observed that the air delivered by the unit in these surveys was directed upward to or near the ceiling and then turned downward, intersecting the 45-in. level near the first row of seats, and then spread out away from the unit and slightly in the direction of the room vent flue opening. Actually, this prevailing air stream was not easily observed and was only charted after many observations. It is therefore not nearly so apparent or as well defined as indicated in the drawings. It was, however, observed to be more or less present with some variation in all of the surveys made.

Table 2 shows that 45 in. above the floor at station 4, or above the seat immediately in front of the unit, an air velocity of 82 fpm with a dry-bulb temperature 67 F, or a dry Kata cooling power of 7.7, was observed. At the 45-in. level at other points in the room not immediately affected by the entering air, the air velocity ranged from 12 to 30 fpm with a dry-bulb temperature range of from 70 to 71.5 F, or a dry Kata cooling power range of 4.2 to 5.3. The difference between the cooling effect felt by a person when seated in these parts of the room and when seated directly in front of the unit is very great, and anyone subjected to the higher cooling power would classify it as a very undesirable draft.

The normal temperature gradient between the floor and the 45-in. level in the portions of the room unaffected by drafts, or in close proximity to radiators, gave temperatures of approximately 68.6, 69.5, 70.2, and 70.7 F at the 6, 18, 35 and 45-in. levels, respectively. This is in close agreement with the temperature gradients for various rooms in this school reported in

Table 1—Showing Relation Between Dry Kata Cooling Power and the Velocity and Temperature of the Air.

Temp. F	KATA COOLING POWER FOR KATA AIR VELOCITIES IN FEET PER MINUTE OF:									
	90 FT	80 FT	70 FT	60 FT	50 FT	40 FT	30 FT	20 FT	10 FT	0 FT
74	6.13	5.89	5.64	5.39	5.10	4.80	4.47	4.13	3.77	3.40
73	6.41	6.16	5.90	5.61	5.31	5.00	4.65	4.30	3.90	3.56
72	6.72	6.45	6.17	5.87	5.55	5.22	4.86	4.50	4.10	3.71
71	6.93	6.66	6.37	6.07	5.75	5.41	5.06	4.70	4.32	3.95
70	7.19	6.92	6.62	6.32	6.00	5.65	5.30	4.93	4.53	4.15
69	7.45	7.17	6.86	6.55	6.21	5.85	5.50	5.11	4.72	4.33
68	7.63	7.43	7.12	6.79	6.44	6.08	5.70	5.30	4.89	4.48
67	7.96	7.66	7.34	7.00	6.65	6.28	5.90	5.50	5.08	4.67
66	8.22	7.92	7.60	7.25	6.89	6.50	6.11	5.70	5.27	4.84

Table 2—Giving Dry Kata Cooling Observations at Most Drafty Points Observed in a Typical Room, 301, with Unit Discharge Temperatures Ranging from 37.5 F to 40 F.

		KATA OBSERVATIONS											
		45 IN. ABOVE FLOOR			35 IN. ABOVE FLOOR			18 IN. ABOVE FLOOR			6 IN. ABOVE FLOOR		
Date	Station	Temp. F	Velocity ft/min	Cooling Power	Temp. F	Velocity ft/min	Cooling Power	Temp. F	Velocity ft/min	Cooling Power	Temp. F	Velocity ft/min	Cooling Power
1/22/35	46	71.0	17	4.58	71.0	22	4.76	72.0	28	4.80	70.0	30	5.30
1/22/35	47	70.5	14	4.57	70.0	18	4.84	69.5	12	4.70	69.5	15	4.82
1/22/35	48	70.5	24	4.94	70.0	35	5.14	69.0	29	5.24	68.0	22	5.38
1/22/35	3	68.0	73	7.22									
2/ 5/35	2	71.5	22	4.65	71.0	24	4.84	71.5	30	4.96	70.0	28	5.22
2/ 5/35	20	70.5	24	4.94	71.0	20	4.70	68.0	35	5.88	66.0	38	6.43
2/ 7/35	35	71.0	18	4.63	70.5	25	4.99	69.0	30	5.49	67.0	35	6.08
2/ 7/35	4	67.0	82	7.72	67.0	50	6.64	69.0	30	5.49	68.0	30	5.70
2/ 7/35	15	69.0	40	5.84	68.0	47	6.34	68.0	28	5.63	68.0	20	5.30
2/ 7/35	22	70.8	21	4.78	70.0	23	5.03	69.0	32	5.57	68.0	33	5.82
2/ 5/35	40	71.0	7	4.21	70.5	0	4.06	70.0	10	4.53	69.0	15	4.92
2/ 5/35	24	70.0	30	5.30	70.0	12	4.61	69.5	28	5.32	68.0	22	5.38
2/ 5/35	8	70.8	12	4.44	71.0	21	4.74	72.0	19	4.45	70.5	20	4.80
1/22/35	11	71.0	20	4.70	70.0	19	4.88	69.0	15	4.92	68.0	12	4.98
1/22/35	26	70.0	22	4.98	70.5	17	4.70	69.5	16	4.75	69.0	10	4.72
1/22/35	44	71.5	12	4.28	71.0	8	4.25	70.0	7	4.42	69.5	5	4.45

Table 3—Kata Velocities and Cooling Power for Different Classrooms and Operating Conditions

DATE	ROOM NUMBER	STATION NEAREST UNIT	LOCATION OF VENT	WORST DRAFT CONDITIONS FOUND IN EACH TEST																					
				UNIT OPERATED AT LOW SPEED								UNIT OPERATED AT INTERMEDIATE SPEED								UNIT OPERATED AT HIGH SPEED							
				TIME	OUTSIDE AIR TEMP. F	UNIT DISCHARGE TEMP. F	STATION NUMBER *	HEIGHT ABOVE FLOOR IN INCHES	KATA OBSERVATIONS			TIME	OUTSIDE AIR TEMP. F	UNIT DISCHARGE TEMP. F	STATION NUMBER	HEIGHT ABOVE FLOOR IN INCHES	KATA OBSERVATIONS			TIME	OUTSIDE AIR TEMP. F	UNIT DISCHARGE TEMP. F	STATION NUMBER	HEIGHT ABOVE FLOOR IN INCHES	KATA OBSERVATIONS		
									TEMP. F	VELOCITY FT/MIN	COOLING POWER						TEMP. F	VELOCITY FT/MIN	COOLING POWER						TEMP. F	VELOCITY FT/MIN	COOLING POWER
1-22-35	302	9	FRONT	2:45	25.0	35.0	9	45	67.3	67.6	6.94	2:58	25.0	35.0	9	45	69.2	42.5	6.15								
1-22-35	301	4	FRONT	12:29	28.0	38.0	4	45	68.0	73.0	7.22	1:00	28.0	38.0	4	45	68.0	51.0	6.28	1:38	28.0	38.0	5	45	71.3	58.5	5.87
1-24-35	302	9	FRONT	1:13	20.0	30.0	9	45	63.9	109.0	9.60									2:31	18.0	26.0	9	45	68.0	90.0	7.70
1-29-35	305	2	REAR	1:12	30.0	41.0	2	45	67.5	55.0	6.75	1:43	28.5	41.0	14	45	70.3	51.0	5.95	1:52	29.0	41.0	2	45	71.6	61.0	6.00
1-29-35	301	4	FRONT	10:22	30.0	39.5	3	45	67.5	70.0	7.24	11:03	30.0	39.5	5	45	71.7	65.0	6.09	11:24	30.5	39.5	3	45	66.8	44.0	6.48
1-30-35	302	9	FRONT	1:24	21.0	31.0	7	45	62.0	44.0	7.60	11:45	19.0	28.0	8	45	67.1	61.0	7.10	11:23	19.0	28.0	8	45	66.8	74.0	7.30
1-30-35	302	9	FRONT	3:00	26.0	36.0	8	45	67.0	67.0	6.95	2:09	24.0	32.0	8	45	68.5	70.0	6.95	2:44	26.0	33.0	8	45	66.6	81.0	7.80
1-31-35	301	4	FRONT	10:16	29.0	35.0	4	45	65.0	63.0	7.06	10:44	30.0	36.0	4	45	68.0	46.0	6.29	11:07	30.0	37.0	4	45	68.5	75.0	7.15
1-31-35	105	2	REAR	1:22	31.0	40.0	1	45	66.8	75.0	7.55	2:27	31.0	41.0	22	45	71.7	47.5	5.62	2:15	31.0	41.0	18	45	70.7	68.0	6.43
2-1-35	301	4	FRONT	10:14	27.5	37.0	4	35	63.8	55.0	7.05	12:00	34.0	45.5	15	45	72.6	45.0	5.23	12:30	35.5	46.2	41	45	63.8	18.0	5.17
2-1-35	307	4	REAR	2:50	38.0	47.5	3	45	72.3	47.0	5.40	2:26	37.5	50.0	4	45	69.8	31.5	5.40	1:48	38.0	52.0	4	45	68.1	43.0	6.14
2-5-35	301	4	FRONT	10:51	31.0	39.0	20	6	66.0	38.0	6.45	3:00	33.0	42.0	22	6	69.4	39.0	5.72	2:25	33.0	42.0	22	6	69.6	43.0	5.83
2-7-35	301	4	FRONT	11:15	28.0	37.5	4	45	68.0	82.0	7.36									11:56	30.5	40.5	4	45	67.1	62.5	7.05
2-7-35	303	4	REAR	1:05	36.0	47.0	4	45	68.9	35.0	5.71	2:09	38.5	44.0	23	45	68.5	52.0	6.62	1:38	37.0	44.7	13	45	69.3	59.0	6.69
2-12-35	301	4	FRONT	11:39	37.0	47.0	3	35	68.5	43.0	5.98	12:54	39.0	49.0	23	6	67.2	44.0	6.04	1:57	42.0	52.5	21	6	70.0	37.0	5.52
3-12-35	303	4	REAR	11:03	32.5	41.0	4	45	68.5	68.0	6.94																
3-18-35	303	4	REAR									11:03	34.5	55.0	15	45	70.8	38.0	5.40								
3-18-35	303	4	REAR									2:50	50.2	52.5	33	45	70.2	43.0	5.71								
3-19-35	303	4	REAR									10:18	45.0	48.5	3	45	70.7	47.0	5.71								
3-19-35	303	4	REAR									11:50	46.0	50.2	22	45	71.5	43.0	5.40								
3-22-35	303	4	REAR									11:40	57.0	59.0	20	45	71.3	51.0	5.71								
3-26-35	303	4	REAR	11:16	44.0	46.7	15	45	70.2	32.0	5.66	10:19	45.5	46.0	4	45	70.8	43.0	5.58	11:21	44.5	46.5	3	45	67.7	62.0	6.76
3-30-35	SMALLER 308	3	WALL OPPOSITE ENTRY									10:52	49.4	53.4	15	45	68.1	33.0	5.79								
4-4-35	SMALLER 209	7	FRONT									9:59	45.0	47.5	11	45	71.2	33.5	5.12								
4-4-35	SMALLER 209	7	FRONT									10:27	48.0	50.5	11	45	71.8	44.0	5.40								
4-4-35	SMALLER 209	7	FRONT									11:16	50.7	52.2	12	45	72.4	38.0	5.01								
AVERAGE ALL TESTS					30.2	39.3			67.2	60.3	6.91		37.8	45.0			70.0	46.0	5.84		31.5	40.4			68.4	58.4	6.52

* SEE FIGURE 1

an earlier Laboratory paper[1]. In studying the draft conditions in affected portions of the room but at different levels, this normal gradient must be kept in mind. It will be observed that 6 in. above the floor at station 20 an air velocity of 38 fpm with a temperature of 66 F, or a dry Kata cooling power of 6.4, was observed, compared with an average condition in the unaffected portions of the room at this level of 15 fpm with a temperature of 68.6 F, or a 5.0 dry Kata cooling power.

In Table 3 there are tabulated the results of surveys in a number of different rooms with different entering air stream temperatures. The one worst draft condition, only, observed in any survey is recorded, together with the prevailing velocity, air stream temperature, and Kata cooling power.

All rooms in the school did not have the arrangement or relative location of seats, unit ventilator and vent flue opening shown in Fig. 1. The vent flue opening might be located in either the front or rear of the room, and in a few instances, the unit ventilator was not located symmetrically in the center, but either near the front or back of the room. These variations in arrangement are indicated in Table 3.

Although the dry Kata cooling power is made use of throughout the paper, it should be emphasized that it alone cannot be taken as an accurate index of a person's feeling of warmth, as shown by earlier Laboratory studies. The effective temperature scale developed by the Research Laboratory has been shown to be an accurate index of a person's feeling of warmth. A 66 deg effective temperature is accepted as the condition for optimum comfort for a person normally clothed and seated at rest indoors during the heating season and with air movements ranging from 15 to 25 fpm. If we accept an air movement of 20 fpm, 66 deg effective temperature will give varying cooling powers ranging from 5.7 at 100 per cent relative humidity, 4.9 at 50 per cent relative humidity, and 3.9 in perfectly dry air. This variation represents the lack of coordination between Kata cooling power and effective temperature as an index of feeling of warmth.

While in general Kata cooling power cannot be accepted as an index of a person's feeling of warmth, variations in the cooling power may, where due consideration is given to relative humidity, be accepted as a very satisfactory index of the relative feeling of warmth and therefore of the sensation of draft. A Kata cooling power of 4.9, resulting from a 66 deg effective temperature, 50 per cent relative humidity, and 70 F dry-bulb, may be accepted for comparison as a most satisfactory air condition. Assuming that a tolerance of approximately 2 deg effective temperature is allowable for reasonably good ventilation conditions, it follows that a variation in Kata cooling power of 0.4 may be accepted, allowing a variation from 4.5 to 5.3.

It should be recognized that a draft has a different effect upon a person than a uniform low effective temperature throughout the room. A person apparently objects less to a lower temperature resulting in a 0.4 increase in Kata cooling power than he does to a localized cooling of the same degree on some parts of the body which we call a draft.

While the conditions available for the study in actual classrooms were not very satisfactory for an accurate study of the relative feeling of discomfort resulting from various air velocities having various air stream temperatures, the following general deductions were arrived at by the observers. An air velocity in the neighborhood of 25 fpm with an air temperature of from 1 to 1½ deg below the prevailing room temperature could be distinguished by its cooling sensation. It would not, however, be classed as objectionable to the observers engaged in the study. Neither was it classed as objectionable by most opinions from children and teachers. In fact, there were more individual opinions expressed that the sensation was pleasant rather than unpleasant. An opinion as to whether such a condition is pleasant or unpleasant is

undoubtedly closely associated with the physical condition of the individual. An air velocity in the neighborhood of 40 fpm with an air stream temperature of from 1½ to 2 deg below the prevailing room temperature, or a Kata cooling power of 6.1 compared with 4.9, was decidedly noticeable and was invariably judged by the observers, students and teachers as unpleasant. Air velocities of 50 fpm or greater and with an air stream temperature of 2 deg or more below the prevailing room temperature, or having a Kata cooling power of 1.5 greater than the surrounding air, was always classed as decidedly unpleasant by the observers and children affected by them for more than a few minutes.

As pointed out above, conditions were not satisfactory for arriving at conclusive opinions of the relative effect of drafts on various parts of the body. Since

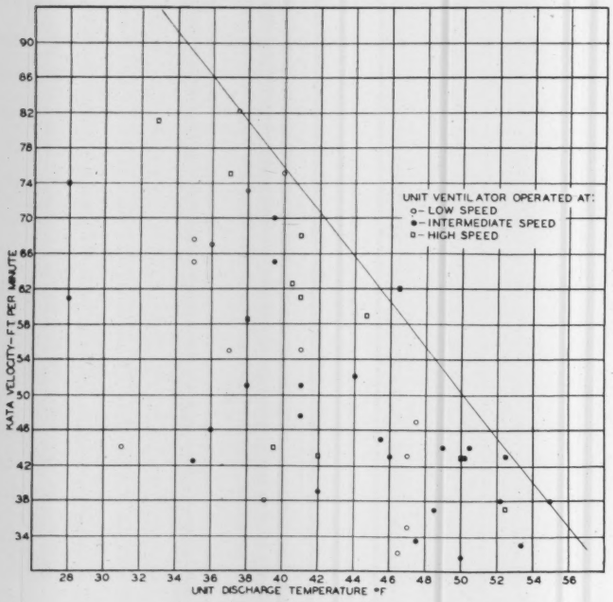


Fig. 4—Relation between unit discharge temperature and velocities for worst condition in each test

a clear understanding of the effect of various air velocities and temperatures on persons at rest is very necessary for an understanding of the application of air conditioning, it is strongly urged that a careful laboratory study be made of the effects of drafts on persons, particularly with respect to velocity and temperature of the air stream and the portion of the body against which it impinges. There was an apparent tendency for the observers to notice as objectionable low temperature air velocities coming from above and behind more than they did similar conditions affecting other parts of the body including the legs below the knee, while the children occasionally complained of drafts near the floor. This may have resulted from the fact that the observers were well-clothed adults who had been fairly active before sitting down to make the observations over a short period of time, whereas, the children wore less protective clothing below the knees and had not recently been active. Also, the vitality of the average child may have been less than that of the observers.

Fig. 4 shows how the air velocity observed in the various tests at the most affected points in the room varied with the discharge temperature of the unit. These points were taken from Table 3. In considering them it should be emphasized that the conditions tabulated in Table 3 are the worst observed in the given surveys, which were not always complete and therefore did not always include the worst conditions in the room. This undoubtedly accounts for the wide dispersion of points. It is noticeable, however, that the observed velocity at the worst points increased with lower discharge temperatures for the conditions and units observed. This demonstrates a fact which may be fairly well accepted—that the excessive air movement observed resulted from the cold air stream falling quickly to the floor because of its greater density. It follows that the cooling power or draft is doubly affected by low discharge temperatures, since cooling power is increased both by high velocity and low temperature.

Fig. 5 shows how the highest cooling power observed in the several surveys varied with the unit discharge temperature. Again in this figure, the dispersion of points may be accounted for by the fact that the tabulated values in Table 3 did not in all cases represent the worst condition in the room. For this reason, the curves drawn in Figs. 4 and 5 are made to indicate the most severe conditions which are likely to occur, rather than to fit the group of points.

Figs. 4 and 5 indicate that air velocities as high as 50 fpm and cooling powers as high as 6.1 may be expected to occur in the rooms studied with an entering air stream of 50 F when the average temperature of the unaffected part of the room is between 70 and 71 F. An entering air stream temperature of 55 F may give high localized air velocities of approximately 38 fpm and Kata cooling powers of 5.5. It therefore follows that for the rooms and for the particular heating and ventilating system studied, the temperature of the air stream discharged by the unit must be limited to

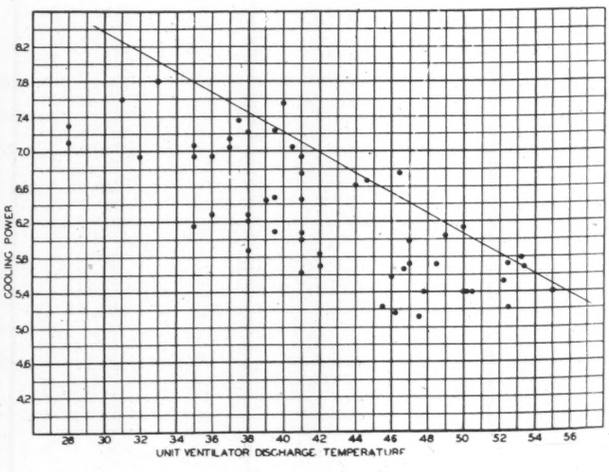


Fig. 5—Relation between unit ventilator discharge temperature and cooling power for worst draft condition in all tests

approximately 55 F, in order to entirely eliminate the probability of localized drafts.

The later model unit used in the Woodlawn school, and the few rooms equipped with another make of unit in the Shaler school were studied when the outside temperature was too mild to obtain very low entering air stream temperatures. These studies do, however, indicate about the same relation between maximum draft observed and entering air stream temperature as was found for the larger number of rooms studied in the Woodlawn school.

Summary

The following deductions may be drawn from the observations made in the several rooms with the prevailing surrounding conditions.

1. Air movement in the affected portions of the room was found to increase with a lower unit ventilator discharge temperature. The resulting cooling power was also found to increase with a lower discharge temperature.

2. Observations of the worst draft conditions within the rooms during a large number of surveys indicate that undesirable conditions of draft may occur whenever the unit discharge temperature falls below 55 F.

3. An air movement of approximately 25 fpm with a temperature of from 1 to 1½ deg below the prevailing room temperature was found to be noticeable but not necessarily objectionable, while a higher velocity of approximately 40 fpm and a temperature of 2 or more degrees below the prevailing room temperature was decidedly noticeable and objectionable.

Kansas City

May 13, 1935. Members and guests of the Kansas City Chapter met at the Newbern Hotel at 6:00 p. m. with an attendance of 40 members and 6 guests. Pres. L. A. Stephenson called the meeting to order and the minutes of the April meeting were read and approved.

G. L. Bliss, treasurer, reported on the Chapter's account and requested that dues be paid.

The chairman of the Membership Committee, E. K. Campbell, announced that 10 new members had been elected to Society membership during the past year. It was pointed out that this is the best record ever made by the Chapter with the exception of the year in which the Society's meeting was held in Kansas City.

W. A. Russell, member of the Council, asked that all application blanks be filled out with more information concerning the engineering experience of the applicant. Mr. Russell discussed several matters before the Council for consideration, one of which proposed changes to the Society's Constitution and By-Laws relating to the Nominating Committee. A motion was made and passed that Mr. Russell be instructed to inform the Council that the Kansas City Chapter desires the Nominating Committee set-up to remain as at present and that the portions of the Constitution and By-Laws relating to the Nominating Committee be unchanged.

Mr. Russell pointed out that L. W. Millis, Kansas City, had been elected to Life Membership in the A.S.H.V.E.

W. E. Gillham, chairman of the Standardization of Air Conditioning Committee, reported upon activities of the Committee.

J. M. Arthur, chairman of the June Meeting Committee, reported that the Oakwood Country Club had been selected as the place of meeting and that music would be provided during dinner and afterwards for dancing. June 3 was then decided upon as the date.

A general discussion followed regarding the amount of money to be taken from the treasury for this social meeting and it was decided that $50.00 would be appropriated and that the cost of the tickets would be $1.50.

A discussion took place concerning affiliation of the Kansas City Chapter with the Club President's Round Table, and a motion was made and passed that the dues be paid to date and that the Chapter withdraw from the organization.

The annual election was held and the following officers were unanimously elected:

President—C. A. Weiss
Vice-President—L. R. Chase
Secretary—G. L. Bliss
Treasurer—C. A. Flarsheim
Directors—L. A. Stephenson, A. L. Maillard, H. M. Rudio.

Mr. Stephenson introduced the speaker of the evening, H. C. Mueller, Chicago, who gave a very interesting talk on Temperature Control with Particular Reference to Summer and Winter Air Conditioning.

After considerable discussion, the meeting adjourned.

New York

May 20, 1935. The annual dinner, entertainment and smoker of the New York Chapter took place at the Building Trades Club and was one of the most successful ever held with over 300 in attendance.

The program included a troupe of accordian serenaders under the direction of Joseph Rossi; music by Bill Gahagan and his Masters of Music; Gene Irving, magician and 2 dancers, as well as a chorus of 6 girls and a mistress of ceremonies.

The new officers of the Chapter for the 1935-36 season were introduced to the members and were W. W. Timmis, *President;* G. E. Olsen, *Vice-President;* T. W. Reynolds, *Secretary;* W. M. Heebner, *Treasurer;* and H. W. Fiedler, A. F. Hinrichsen and W. E. Heibel, *Board of Governors.*

The party did not break up until after midnight and was in charge of the following committee: H. L. Alt, Chairman; J. A. Heller, M. G. Scheutz and W. K. Walker.

St. Louis

June 8, 1935. The St. Louis Chapter held a dinner dance at the Norwood Hills Country Club, in lieu of the regular monthly business meeting. This was the last activity before the summer interim and approximately 90 members and guests attended.

The party was arranged by the Entertainment Committee, composed of E. E. Carlson, Chairman, D. J. Fagin, J. E. Manahan, and L. R. Szombathy.

May 14, 1935. Following dinner at the Kingsway Hotel with about 28 members and guests present, the meeting was called to order by Vice-Pres. C. R. Davis. The minutes of the previous meeting were read and approved.

Secy. A. L. Walters read correspondence in regard to the Semi-Annual Meeting of the Society in Toronto and it was suggested that the Chapter communicate with Secy. A. V. Hutchinson of the A.S.H.V.E. and bring to his attention the invitation to hold a Society meeting in St. Louis.

The treasurer's report was given and showed a balance of $409.68.

E. E. Carlson, chairman of the Entertainment Committee, outlined plans for the June party.

G. W. F. Myers introduced W. C. Chapman, who spoke on Compressors and Expansion Valves and covered their application to air conditioning. In his talk, Mr. Chapman discussed the thermodynamic principles applying, which were also portrayed in motion pictures.

After a rising vote of thanks, the meeting adjourned.

PRESIDENT'S MESSAGE TO MEMBERS

VACATION

With the coming of July, thoughts turn to the subject of vacation days and we listen more attentively to the siren songs of those promoting an outing in the open spaces.

I extend my sincere wishes to the members of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS for a pleasant recess from the trying days we have gone through and trust each will gather energy during the vacation period so he will attack the work ahead with renewed vigor upon his return.

As engineers, we must possess reasoning powers and especially high qualities of resistance to the panaceas and nostrums that always attend periods of great social stress; for that reason it will not be necessary for me to caution you against the "tub thumpers" and the rabble rousers who now seem to occupy the center ring not only in America but throughout the world.

Go forward with your vacation plans fortified by the assurance that whatever of lasting benefit is accomplished will be accomplished by calm analysis and by adherence to scientific principles. A restful vacation is an excellent means of getting away from the mob psychology that is so destructive of reason and orderliness and for putting one in the proper frame of mind for further constructive thought and action.

John [illegible] President,

July 1, 1935. AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Opens Industrial Sales Division

Announcement has recently been made by John J. Nesbitt, Inc., Holmesburg, Philadelphia, Pa., of the association of H. B. Hedges as manager of industrial sales. Mr. Hedges has been identified with the heating, ventilating, and air conditioning industry since 1914 and has gained experience with Buffalo Forge Co., Carrier Engineering Co., Du Pont Co., Kewanee Boiler Co., York Heating & Ventilating Corp., Carrier Corp., and Niagara Blower Co.

A. S. R. E. Holds Meeting

The members of the Detroit Section of the *American Society of Refrigerating Engineers* were hosts during the 22nd Spring Meeting, held May 22-24, 1935, with headquarters at the Hotel Statler, Detroit, Mich. Three technical sessions were held on Wednesday, Thursday and Friday mornings, and enjoyable entertainment was provided for member and guests in the afternoons.

At the first session, on air conditioning, May 22, Harry Harrison, president of the *A.S.R.E.*, presided and the following papers were presented: Air Conditioning and Odor Control by Philip Drinker, Cambridge, Mass.; Window Glass as Insulation by C. D. Haven, Milwaukee, Wis.; and Rational Development and Rating of Extended Air Cooling Surfaces by H. B. Pownall, York, Pa.

G. B. Bright, past president, served as chairman of the second session at which commercial machinery was discussed and papers on this topic were given on Refrigerated Display Windows by H. C. McPherson, Cincinnati, O., New Investigation of Absorption Refrigeration by B. H. Jennings, Bethlehem, Pa., and Motor Truck Refrigeration and Fuel by G. L. Tinkham, Detroit, Mich.

The final technical session was held May 24 and was devoted to progress in standards. S. C. Bloom, vice-president of the *A.S.R.E.*, presided. Industrial Machine Standards were discussed by A. B. Stickney, Chicago, Ill., and a paper on Testing and Capacity of Expansion Valves was given by D. D. Wile, Detroit, Mich.

H.P. & A.C.C.N.A. Annual Convention

The 46th Annual Convention of the *Heating, Piping and Air Conditioning Contractors National Association* was held in Cincinnati, Ohio, at the Hotel Gibson, May 20-22, 1935, and was attended by approximately 200 members and guests.

At the final business session on the afternoon of May 22, the following officers were re-elected: *President*—J. L. DeNeille, St. Louis. Mo.; *Vice-President*—J. H. Zink, Baltimore, Md.; and *Treasurer*—M. J. Chagnard, Louisville, Ky. Five directors were elected for a term of three years: F. E. Kise, Cincinnati, Ohio, J. J. Nolan, Memphis, Tenn., A. C. Rodoni, San Francisco, Calif., G. E. Smith, Denver, Colo., and R. D. Williams, New York, N. Y. Of this group Messrs. Nolan, Smith, and Williams were also reelected.

The principal speaker at the opening session, Monday morning, was Prof. H. H. Maynard, Ohio State University, who spoke on Can Business Govern Itself?

A trade promotion and trade relations session was held on Tuesday morning when H. S. Snow, Boston, Mass., presided. Among the speakers were R. G. Creviston, Chicago, Ill., H. O. Nelson, Detroit, Mich., and J. A. Kiesling, Houston, Tex.

On the afternoon of May 21, a special code session was conducted by R. D. Williams, Chairman, Divisional Code Authority, and J. C. Fitts, Executive Director for the code, and a round-table discussion took place.

At the Wednesday morning session, a number of committee reports were given and M. J. Beirn and A. R. Herske, New York, N. Y., and J. J. Nance, Dayton, O., were among the speakers.

The local committee had provided enjoyable entertainment for both members and ladies.

Air Conditioning Manufacturers Meeting

Over 40 representatives of the leading manufacturers of air conditioning equipment met at Hot Springs, Va., May 23, at the annual meeting of the *Air Conditioning Manufacturers' Association*, presided over by P. A. McKittrick.

New officers and directors of this air conditioning manufacturer's group were elected to guide the policies of *ACMA* in the coming year. The new Board of Directors consists of C. T. Morse, American Blower Co.; Thornton Lewis, Carrier Engrg. Corp.; H. C. Grubbs, De La Vergne Engine Co.; W. F. Armstrong, Frigidaire Corp.; J. J. Donovan, General Electric Co.; J. A. Harlan, Kelvinator Corp.; S. F. Myers, Westinghouse Elec. & Mfg. Co.; and S. E. Lauer, York Ice Machinery Corp.

P. A. McKittrick, Parks-Cramer Co., Fitchburg, Mass., was elected President and J. F. G. Miller, B. F. Sturtevant Co., was elected Vice-President of the association.

Mid-year Meeting of Furnace Manufacturers

The *National Warm Air Heating and Air Conditioning Association* held its mid-year meeting at the Deshler-Wallick Hotel, Columbus, Ohio, June 4-6. Tuesday, June 4, was devoted to committee meetings, and a meeting of manufacturers.

Pres. H. T. Richardson, New York, N. Y., opened the meeting on Wednesday morning and among the speakers were E. A. Jones, Milwaukee, Wis., who discussed Fundamentals of Air Conditioning; T. W. Torr, Dowagiac, Mich., who spoke on Conditioned Air—Its Installation, Equipment and Problems; H. F. Randolph, Utica, N. Y., on The A B C's of the Standard Code; and J. W. Norris, Marshalltown, Ia., who addressed the meeting on Trouble Jobs, the Responsibility of the Manufacturer, Jobber and Dealer Therewith. Prof. J. D. Hoffman, Purdue University, reported as Chairman of the Committee on Installation Codes.

At the afternoon session, Vice-Pres. W. L. Rybolt presided and explained the necessity of changing the program because of the recent decision of the Supreme Court relative to NRA. He introduced J. H. Manny, who told of the work being done by the Committee of Ten—Coal and Heating Industries. Several committee reports followed.

J. S. Irvine, Toledo, O., spoke on This Warm Air Furnace and Air Conditioning Business and C. S. Stout, Marshall, Mich., discussed Engineering—Benefit or Bunk. A paper on the control of Fans and Blowers in Warm Air Heating Plants, which had been prepared by N. B. Delevan, Des Moines, Ia., was read.

The Thursday morning session was devoted to Research, and E. A. Scott reported on the progress of the new research data book. F. G. Sedgwick, Minneapolis, Minn., Chairman of the Research Advisory Committee, outlined progress made in recent tests and presented the need for additional funds. Research work at the University of Illinois was discussed by Prof. A. P. Kratz, who spoke on Combustion Rates, Including the Temperature of Furnace Castings, and by S. Konzo, who gave a progress report on Oil Conversion Burner Tests.

J. M. Robb Dies

Friends of John M. Robb will be saddened to learn of his death on May 10, 1935, in St. Francis Hospital, Peoria, Ill. Mr. Robb's enthusiastic interest in his work was one of his outstanding characteristics and can be best expressed by the following quotation from a recent letter: "The sight of a new building, heating mechanics at work, heating literature, the smell of heat when a new plant is put into service, etc., will always have the effect that battle sights and sounds are said to exercise upon an old war horse."

Mr. Robb was born March 13, 1874, at Akron, Ohio, and received his education in the public schools and St. Canisius College. He was apprenticed in heating and plumbing at Akron from 1889 to 1896 with John Robb, Hill & Cahill, and C. M. Ginther. Mr. Robb was with Meahl, Robb & Co. from 1890 to 1891 and he was associated with the Akron Gas Co. from 1896 to 1899 as shop foreman.

Affiliation with the Peoria Gas & Electric Co. began in 1899, and he advanced from draftsman to secretary and treasurer. During 1906 to 1907 he also served as secretary of the *Illinois Gas Association*, and in 1907 he was general manager of the Chattanooga Gas Co.

From 1908-1910, Mr. Robb acted as consulting engineer in Peoria and later he was chief engineer for the Moline Vacuum Vapor Heating Co., vice-president of Moline Heat, and was associated with the Herman Nelson Corp. as director of service. For a long period of years, Mr. Robb operated as a consulting engineer at his home, 1513 Columbia Terrace, Peoria, Ill.

Mr. Robb was elected a Member of the American Society of Heating and Ventilating Engineers in December 1913 and he was also a member of the Knights of Columbus and of St. Mark's Church.

The Officers and Council extend their sympathy to his widow, Mrs. Matilda Slevin Robb, who survives, as well as three daughters, two sons, and three grandchildren. Also surviving are two sisters and three brothers.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 13 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by July 15, 1935, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	*REFERENCES*	
	Proposers	*Seconders*
ARNDT, H. W., Div. Head, Sears, Roebuck & Co., Augusta, Ga.	C. H. Manly H. Allen	A. A. Rice *(Non-Members)* W. F. Conlon *(Non-Members)*
DENISE, JOHN R., Asst. Com. Engr., Consolidated Gas Co., New York, N. Y.	E. D. Milener *(A.G.A.)* D. L. Caldwell *(Non-Member)*	W. R. Zuhlke O. O. Oaks
EMERY, GORDON W., Service Engr., H. H. Van Saun, Inc., Hackensack, N. J.	Pensyl Mawby W. F. Van Saun *(Non-Member)*	E. W. Peters *(Non-Member)* G. W. Seiler *(Non-Member)*
FOX, JOHN H., Engr., Minneapolis-Honeywell Reg. Co., Ltd., Toronto, Ont., Can.	Thomas McDonald M. W. Shears	H. D. Henion E. T. Flanagan
GOUEDY, K. E., Sales Engr., Modern Bldg. Insulating Co., Atlanta, Ga.	C. L. Templin F. W. Clare	M. W. Wise *(Non-Member)* F. E. Baird *(Non-Member)*.
KOCH, RICHARD G., Supervisor, Milwaukee Gas Light Co., Milwaukee, Wis.	C. H. Randolph Ernest Szekely	G. L. Larson E. A. Jones
MACK, LUDWIG, Office Mgr., Cooling & Air Conditioning Corp., Philadelphia, Pa.	M. G. Kershaw A. E. Vroome	L. C. Davidson J. H. Hucker
MILLER, EDGAR R., Chief Engr., Winnipeg Cold Storage, Winnipeg, Man., Can.	C. H. Turland B. G. Jones	D. F. Michie William Glass
MILLS, HARTZELL C., Sales Engr., Minneapolis Gas Light Co., Minneapolis, Minn.	J. E. Swenson A. B. Algren	F. B. Rowley R. E. Backstrom
MOON, FRANK L., Utilization Engr., Los Angeles Gas & Elec. Corp., Los Angeles, Calif.	E. H. Kendall W. H. C. Ness	W. H. Barnum A. G. Orear
MUNN, E. FITZ, Partner, Over & Munn, Winnipeg, Man., Can.	C. H. Turland D. F. Michie	J. B. Steele William Glass
SIMPSON, ARTHUR M., Gen. Sales Mgr., Van Kannel Revolving Door Co., New York, N. Y.	K. B. Atkinson J. F. Munder, Jr.	R. D. Blanchard *(Non-Member)* Campbell Carrington *(Non-Member)*
WAUNG, T. F., Chief Htg. & Vtg. Engr., Andersen, Meyer & Co., Shanghai, China *(Advancement)*.	N. S. Loh I. K. Kwan	P. Y. Loo J. P. Cosgrove *(Non-Member)*

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

ALEXANDER, S. W., Mgr., Htg. Div., Jas. Morrison Brass Co., Toronto, Ont., Can.

BAKER, C. T., Consulting Engr., Atlanta, Ga.

BLACKHALL, L. C., Engr., Gurney Foundry Co., Ltd., Toronto, Ont., Can.

BLAKELEY, H. J., Htg. & Vtg. Engr., Office of Hollis French, New Haven, Conn.

CONRAD, ROY, Application Engr., Kelvinator Corp., Detroit, Mich.

COOPER, A. W., Br. Mgr., Johnson Service Co., Los Angeles, Calif. *(Reinstatement and Advancement)*.

JENNINGS, S. A., Chief Draftsman, Trane Co. of Can., Ltd., Toronto, Ont., Can.

JIMENEZ, J. G., Director, Joaquin Gil Jimenez Co., Madrid, Spain.

JOHNSON, A. J., Director, Anthracite Inst. Laboratory, Primos, Del. Co., Pa.

KIRKPATRICK, A. H., Dist. Mgr., Ilg Elec. Vtg. Co., Detroit, Mich. *(Advancement)*.

KRIBS, C. L., JR., Consulting Mech. Engr., Kribs & Landauer, Dallas, Tex.

LAUTERBACH, HENRY, JR., Asst. Chief Engr., Carrier Engrg. Corp., Dallas, Tex.

LEGLER, F. W., Office Mgr., Waterman-Waterbury Co., Minneapolis, Minn. *(Advancement)*

MADDUX, O. L., Chief Engr., United Gas & Fuel Co. of Hamilton, Ltd., Hamilton, Ont., Can. *(Advancement)*

MAXWELL, G. W., Jr. Member, Kenealy & Maxwell Co., Harwich Port, Mass. *(Advancement)*.

POGALIES, L. H., Mech. Engr., Wilbur Watson & Assoc., Cleveland, O. *(Reinstatement)*

TASKER, CYRIL, Research Fellow in Fuels, Ontario Research Foundation, Toronto, Ont., Can.

WEBB, E. C., Mgr., Engrg. Service, Iron Fireman Mfg. Co., Cleveland, O.

WHITNEY, C. W., Gen. Mgr., Trilling & Montague, Philadelphia, Pa.

WOLFF, P. P., Engr., Bell & Gossett Co., Chicago, Ill.

ASSOCIATES

GAULEY, E. R., Sales Engr., W. H. Cunningham & Hill, Ltd., Toronto, Ont., Can.

KAISER, FRED, Dist. Mgr., Minneapolis-Honeywell Reg. Co., Buffalo, N. Y.

KYLE, W. J., Power Sales Engr., Byllesby Engrg. & Mgt. Corp., Chicago, Ill.

MUNSON, J. L., Instructor, Pratt Inst., Brooklyn, N. Y.

STENGEL, F. J., Secy., R. F. Stengel & Son, Irvington, N. J.

TILLER, LOUIN, Design Engr., Okla. Gas & Elec. Co., Oklahoma City, Okla. *(Advancement)*.

JUNIORS

CORNWALL, C. C., Engrg. Dept., The Bahnson Co., Winston-Salem, N. C.

FARBMAN, LEONARD X., Engr., Morris Farbman, New York, N. Y.

KAMPISH, N. S., Draftsman, Cooling & Air Cond. Corp., New York, N. Y. *(Advancement)*.

KASTNER, G. C., JR., Sales Engr., Phillips & Ibsen, Inc., New York, N. Y. *(Advancement)*

MCLAREN, F. S., JR., Air Cond. Engr., Frigidaire Corp., New Orleans, La.

MEARS, L. A., Air Cond. Com. Engr., General Electric Co., Oakland, Calif.

ROSENBURG, WILLIAM E., Asst., John C. Rosenburg, Locust Valley, L. I., N. Y.

TODD, S. W. JR., Sales Repr., American Radiator Co., Grand Rapids, Mich.

BEFORE YOU DECIDE ON ANY *Air Conditioning* FRANCHISE

GET THE FAIRBANKS-MORSE PROPOSITION *first*

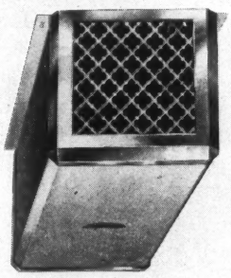
All the world loves a winner . . . not only because the winners stay ahead of the field, but because winners pay profits!

Before you decide upon any air conditioning franchise, look beyond the printed profit percentages that will be offered you. Look beyond the usual claims of a superior line, of more acceptance for the equipment. Find out about the manufacturer . . . his policies . . . how he protects and helps his dealers . . . his success, not only in air conditioning, but in the design and sale of his other products that are distributed through dealers and distributors.

The Fairbanks-Morse Ortho-Clime Air Conditioning Franchise covers *more* than just a line of equipment to sell. It covers motor, compressor and unit design second to none . . . a century of precision manufacture . . . the experience and the facilities for building a first-quality line. And beyond these, it carries the prestige and the acceptance gained by Fairbanks - Morse products in every field of industry.

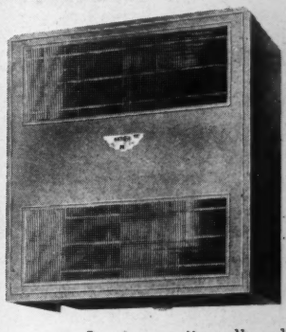
There is still room for a few alert distributors and dealers. For full information on the complete line and the F-M proposition, mail the coupon. Fairbanks, Morse & Co., Air Conditioning Division, 900 S. Wabash Ave., Chicago, Illinois.

GET YOUR COPY OF THIS FREE BOOKLET TODAY



Ceiling model ORTHO-CLIME —also available for wall mounting.

Floor model ORTHO-CLIME. Handsome in appearance, efficient in performance.



Large capacity wall model ORTHO-CLIME.

A STATEMENT OF POLICY

Fairbanks - Morse Air Conditioning equipment is and will be sold only through distributors and dealers. Under no condition will it be sold direct to consumers.

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Please mail me ( ) free booklet on F-M Ortho-Clime air conditioners ( ) information on the F-M franchise.

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Organization.....

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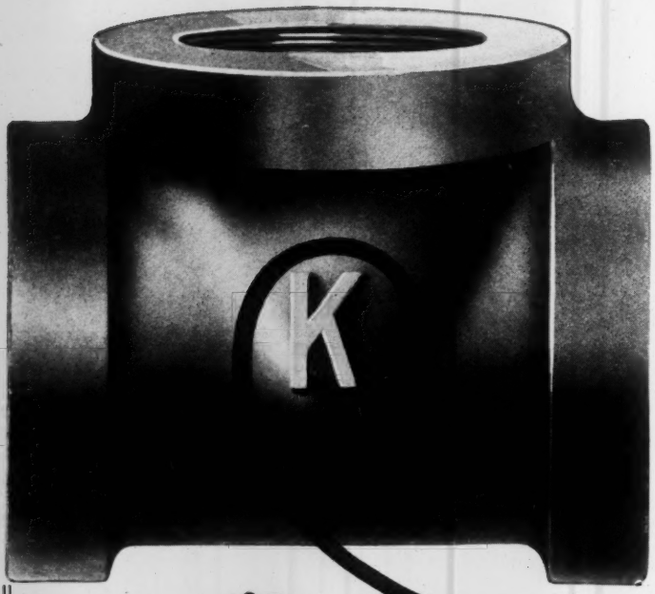

Your Guarantee

This is an invitation to YOU to adopt "K" cast iron fittings, if you have not already done so. So order some "K" 's for the next job, do some comparing and learn that different makes of fittings vary tremendously *in analysis—in design, smoothness of casting, way they're threaded—way they make up.*

Complete line *Quantity production*
Heavy inventories for quick shipment
No job too big *No delivery speed too fast*

Standard and extra heavy screwed fittings—American sprinkler fittings—standard flanged fittings—standard and extra heavy companion flanged fittings—AND DRAINAGE FITTINGS, A NEW LINE just announced.

All fittings hand inspected. Extra heavy screw, American Sprinkler and flanged fittings hydrostatically tested to 300 lbs.

CATALOG TO PLUMBERS AND INDUSTRIAL USERS UPON REQUEST

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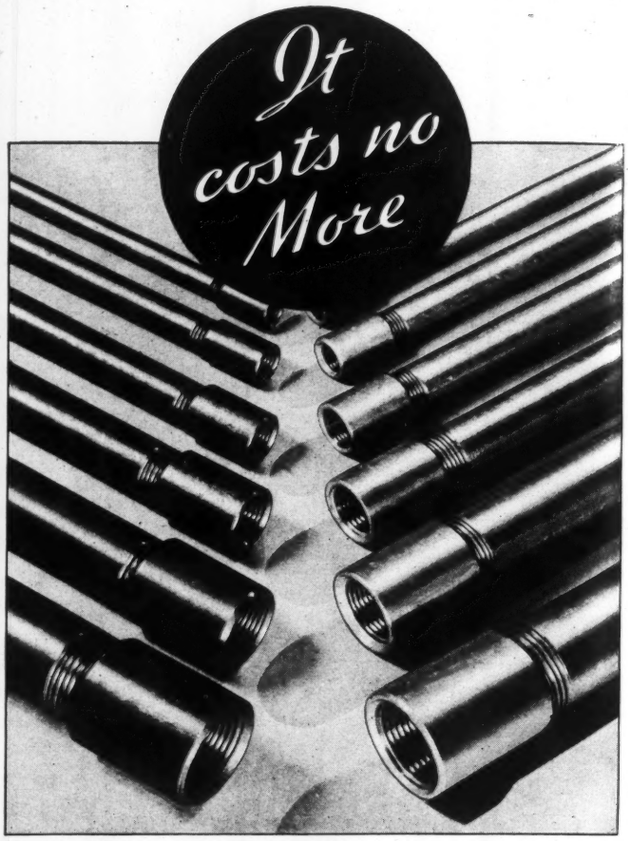
Important

Combined marketing facilities on both "K" cast-iron fittings and M. I. F. malleables. Complete stocks at both Dayton, Ohio, and Branford, Connecticut.



TO USE THIS BETTER STEEL PIPE

In most cases it costs less to use Fretz-Moon Pipe—even though it is recognized as a product of highest quality and uniformity.

Figure it out for yourself. If the steel pipe you use is absolutely uniform—if every length is true to size, perfectly round, tightly welded, straight, accurately threaded, clean inside and outside and, in the case of galvanized finish, with a non-scaling, rust-resisting zinc alloy surface—if it bends, cuts and threads easily and is free from hard or burnt spots in the metal—then, obviously, it should cost less to install.

And that is why Fretz-Moon Pipe is less expensive to use—because it offers these advantages. Judge for yourself. Try it on your next job and note the difference.

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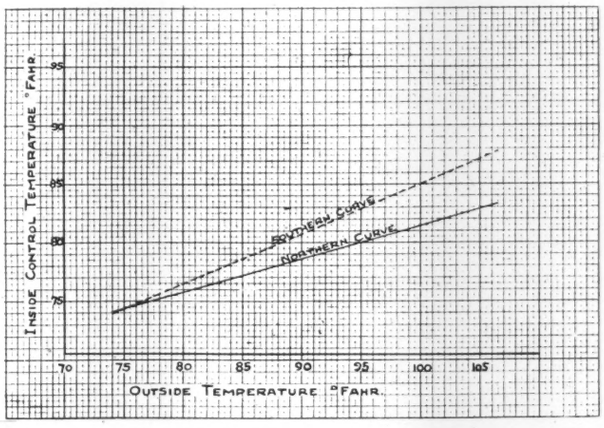
Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 97 . . . Add the new products and companies listed here to your Directory Section which you received in your January 1935 HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up-to-date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed.

Differential Thermostat for Air Conditioning Control

No. 327—The *American Society of Heating and Ventilating Engineers* "Comfort Curve" marks very closely the relative amount of cooling needed in the Northern part of the U. S. to assure comfort indoors during the hot weather. It is generally recognized however, states the Detroit Lubricator Co., that the temperature range represented by this curve is too low for maximum comfort throughout the Southern states, where both temperature and humidity are appreciably higher during the summer season. The accompanying chart indicates the difference in relative comfort temperatures for the two regions. The lower curve is the *A. S. H. V. E.* "Comfort Curve" which coincides with the cooling demands in the North. The upper curve represents the desired comfort conditions in the South. Obviously, this presents a problem in temperature control practice.



The new differential thermostat (No. 691) manufactured by this company was designed to answer this problem. This instrument is supplied in either a Northern range corresponding to the lower curve on the chart or a Southern range corresponding to the upper curve. By a simple factory adjustment, these temperature ranges may be shifted up or down slightly if desired. This adjustment, when made, changes all points on the curve by an equal amount, and is necessary only to meet special conditions.—Detroit Lubricator Co., Detroit, Mich.

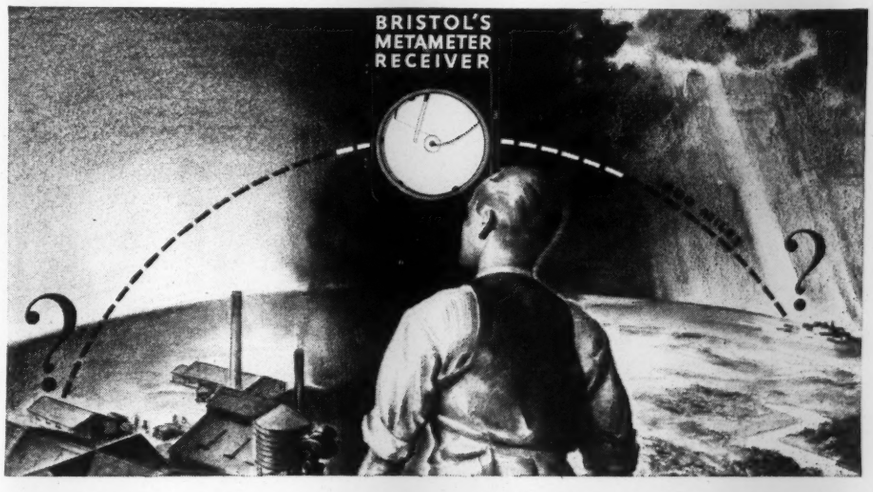
Timing Relay for Starting Air Conditioning Compressors

No. 328**—New timing relay designed to meet the demand for an accurate, long life timer which will operate consistently under extreme conditions without the need for constant servicing is composed essentially of a thermal relay which operates a magnetic contactor. The thermal relay may be calibrated to operate with a delay of a few seconds or several minutes. This device is the nerve center of the assembly, and is completely sealed in a glass tube from which all air has been exhausted. The thermal relay is mounted with the magnetic contactor in a

KNOW AT YOUR DESK...
what's happening in your plant

What would it mean to you in improving operations to know throughout the day the pressures or temperatures of your processing? Or the flow of steam, air, gas or liquid to and from every department? Or anything else that is happening in the plant, or in pipe lines thousands of miles away?

Bristol's Metameter Long Distance Transmitting System will tell you,—accurately and instantly. It consists of (1) a recording receiver in your office, or other conveniently central place; (2) a transmitter at the far point where the measurement is being made; and (3) a simple circuit of two small gauge wires (or any existing telephone lines) for carrying the electric impulses automatically sent out by the transmitter.



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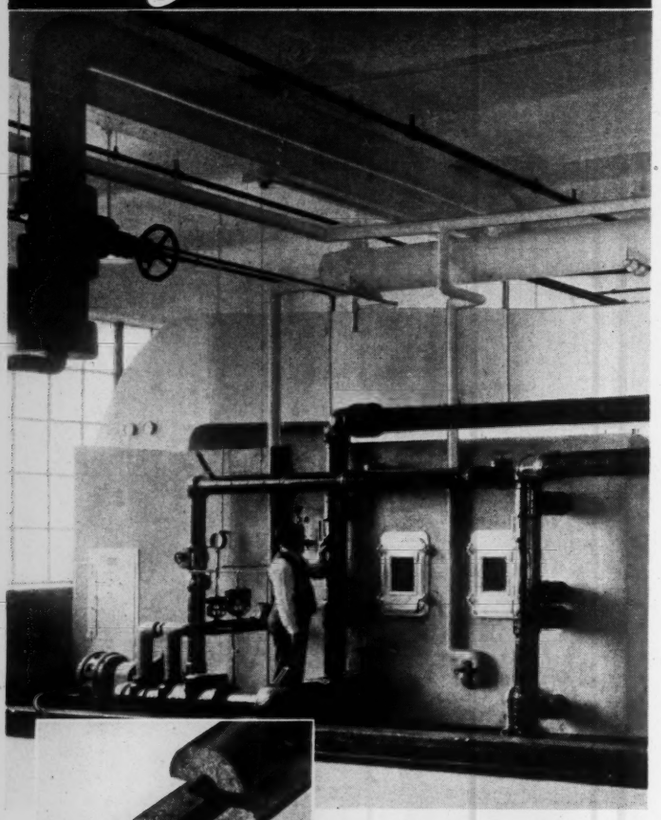
TRADE MARK REG. U. S. PAT. OFF.
METAMETER
FOR TELEMETERING

THE BRISTOL COMPANY
WATERBURY, CONNECTICUT
Branch Offices in Principal Cities
Canada:
The Bristol Company of Canada, Ltd., Toronto
England:
Bristol's Instrument Co., Ltd., London, S.E. 14

MUNDET *Jointite* TRADE MARK CORK PRODUCTS



Above is partial view of the air conditioning unit in the modern Daily News publishing plant, Brooklyn, N. Y. Illustration shows "Jointite" Pipe Covering with canvas and mineral rubber finishes.

To secure efficient operation and permanent protection, all cold lines and ducts in the air conditioning system of the *Daily News* have been insulated with "Jointite" Corkboard and Moulded Cork Pipe Covering.

The surest way to obtain economical temperature control is to specify cork insulation. Mundet Cork products are made of 100% pure cork, the finest grade obtainable. They offer to the Air Conditioning Industry the same high quality and low transmission coefficient per inch of thickness that have maintained universal acceptance for Mundet cork insulation.

★ MUNDET NATURAL CORK ISOLATION MATS solve the problem of machine vibration. Write for a free copy of our new 1935 Catalog, or refer to Sweet's Architectural Catalog.

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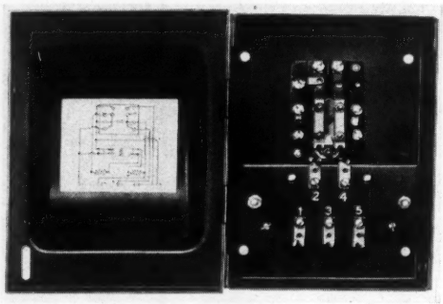
450 SEVENTH AVENUE, NEW YORK, N. Y.

standard switch box. The assembly is wired to a readily accessible terminal board. The magnetic contactor is provided with a spare set of contacts so that the unit may be used for sequence closing of two or more circuits. The timing relay is available for use on d-c as well as a-c.

This timing relay is ideally suited for starting compressors in sequence in air conditioning, states the maker. In many installa-

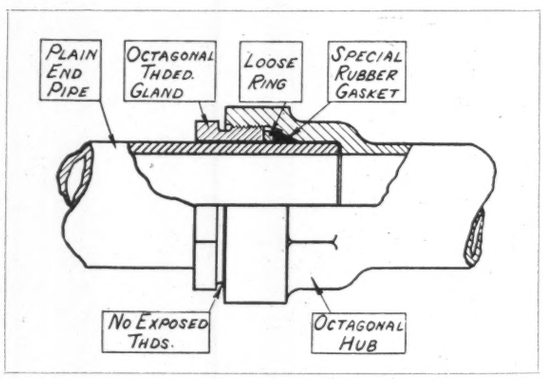


tions several compressors are used for across-the-line starters and because of the large inrush current, the demand load would be very heavy. Allowing 20 to 30 seconds time between the starting of each compressor accordingly reduces the cost of current.

In addition to effecting economy in operating expense, the relay, through the reduction in starting current, makes possible the use of existing wiring in the building where the installation is made, thus eliminating the expense of special wiring for the compressors.—Thomas A. Edison, Inc., Electrical Controls Div., Orange, N. J.

Cast Iron Pipe for Severe Service

No. 329—New "Hi-Test" cast iron pipe, developed for water and gas lines where difficult service conditions prevail is suitable for water working pressures of 175 lb per sq in.; regularly furnished in sizes 1¼ to 6 in., 20 ft. lengths, with threaded joints for rapid assembly above ground; can also be supplied in 5, 10 and 15 ft lengths. Expansion joints, easily made up with open end

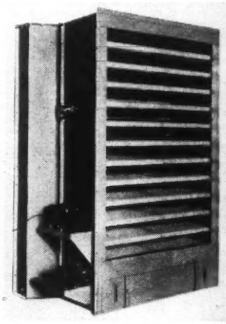


wrenches after sections as long as 80 to 100 ft have been lowered into the trench, provide for axial and to some extent for lateral movement, and assure a bottle-tight joint under the service conditions for which the pipe has been designed, says the maker.

The cast iron used has an ultimate tensile strength of 35,000 lb per sq in. Minimum bursting pressures for the threaded pipe range from 7,000 lb for the 1¼ size to 1,500 lb for the 6 in. If required, each length will be tested to a hydrostatic pressure of 500 lb per sq in.—Walworth Co., 60 E. 42nd St., New York, N. Y.

Automatic Dry-Type Air Filter

No. 330—New automatic, self cleaning, dry type, air filter ("Dry-Matic") uses a specially woven cotten fabric as the filter medium. When the air passes through this filter material, the dust particles are sifted out and deposited on the filter curtain. Once a day to once a week, according to the dust concentration



in the air, the filter curtain starts to move slowly over a dust drawer at the bottom of the filter housing and at the same time a rotary beater is set in operation. This may be accomplished either manually or automatically.

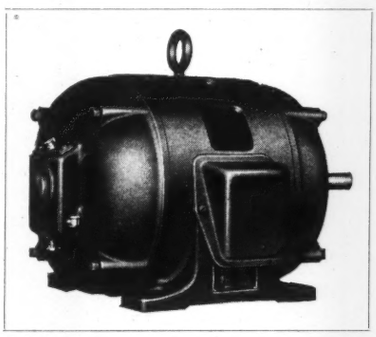
Soft leather fringes beat the curtain on the clean air side with the result that all dust is shaken off into the dust drawer. After a complete cleaning cycle which lasts from 8 to 15 minutes, according to the height of the filter, the drive motor as well as the beater motor stops automatically. The only attention necessary is the removal of the accumulated dust from the dust drawer 3 to 4 times a year.

The filter element runs in a zig-zag fashion, in the shape of an endless belt, over rolls, thus forming horizontal, tapered pockets.—Coppus Engrg. Corp., 374 Park Ave., Worcester, Mass.

Squirrel Cage Motors for Air Conditioning

No. 331—New line of squirrel cage normal torque and high torque motors is especially designed for refrigeration and air conditioning application, including the latest designs of freon compressors.

Special attention has been paid to mechanical stability, the construction including cast frame and end brackets, ample sized



shafts and bearings and well anchored field and rotor cores. Electrolytic copper bars and end rings are so joined as to form a homogeneous high conducting joint.

The motors are available in sleeve or ball bearing designs in sizes 600 hp and smaller.—Century Electric Co., 1806 Pine St., St. Louis, Mo.

Air Conditioners for Hotels, Club Quarters

No. 332—Four new low side units for air conditioning have been designed and produced after a survey of air conditioning needs in hotels, club quarters, etc. The units are said to provide practically all the advantages of concealed duct systems for those

AEROFIN

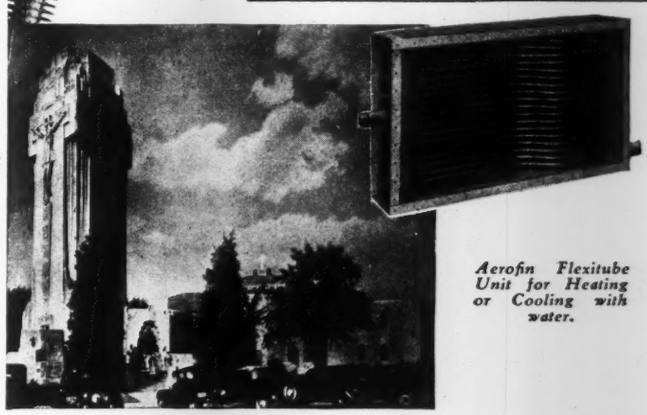
HEATING OR COOLING SURFACE

There is nothing more modern than Aerofin Standardized Light-Weight Fan System Heat Exchange Surface.

For either Cooling or Heating applications, Aerofin is the choice of important architects, engineers and contractors because it gives complete satisfaction and unvarying performance.

Aerofin begins where ordinary surface leaves off. Its exclusive features in design and construction make it the most advanced surface available today. It is furnished in aluminum, copper or other special metals.

The home office in Newark or any branch office will gladly send descriptive literature or render prompt, personal and efficient technical cooperation. Simply write to the address below.



Aerofin Flexitube Unit for Heating or Cooling with water.

The Shrine of The Little Flower, Royal Oak, Mich. has Aerofin heating surface. Architect, Henry C. McGill, New York; Consulting Engineer, William Brown, Detroit; Heating Contractor, Fred J. Douglas, Birmingham, Michigan.

AEROFIN is sold only by Manufacturers of Nationally Advertised Fan System Apparatus. List upon Request

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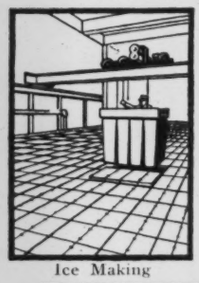
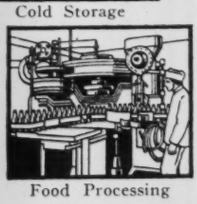

Ice Making

Test and Research

Cold Storage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Time was when "ice machines" were used only for brewery work, ice making, and cold storage. Today, Refrigeration will serve your clients in a dozen profitable ways, performing any of the following jobs:

Air conditioning
Cooling drinking water
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Cooling boxes and display cases
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Precooling fruits before shipment
Making block ice, ice cubes, ice chips or dry ice
Keeping furs, flowers, candy, serums, etc.
Freezing ice cream and other desserts
Transporting under refrigeration
Sinking shafts in quick-sand
Quick-freezing fish, poultry, etc.
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Let the nearest Frick man aid you in adapting Refrigeration, the New Tool of Industry and Business, to your particular problems. No obligation; but write, wire or phone NOW.

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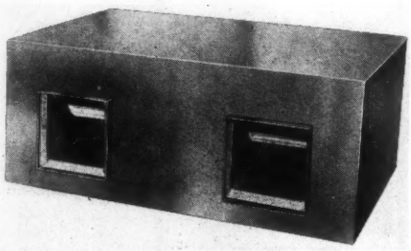
places in which the use of duct work would not be practicable or desirable. They are intended primarily for installation inside of closets, bathrooms or other small spaces adjoining the guest sleeping or living rooms. Grilled openings to the room admit the conditioned air and return air is taken to the unit directly through other grilled openings in walls or through louvers or grilles in closet doors. They may also be used in connection with short localized duct systems wherever necessary to make installations more practicable.

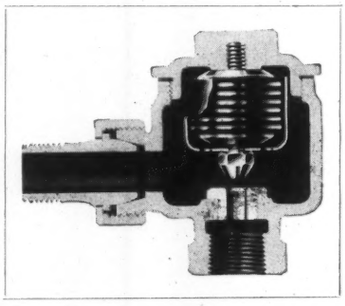


Available in two distinct types each of which is produced in both 1 and ½ ton capacities, the series "H. U. 50" and "H. U. 100" (illustrated) are low in design and provide for return air through the rear, while models "HU 51" and "HU 101" are of the vertical design with provision for return air through the lower end of the front panel. This front opening can be grilled directly or be placed adjacent to wall openings which are fitted with louvers, grilles or screens. Both 1 ton units are equipped with double centrifugal blowers and the ½ ton units have single blowers.

Compressors required for operating these units may be located at any convenient point in the building.—Frigidaire Corp., Dayton, Ohio.

Two New Steam Traps

No. 333—Two new steam traps have been introduced. Style "AU" (illustrated), with union connection and of bronze construction, is adaptable for radiators and unit heaters where reduced high pressure steam is used. In event the reducing valve should stick or get out of adjustment and the pressure increase up to as high as 150 lb, it will not damage the bellows element of this trap, states the maker. The bellows are made from phosphor bronze tubing hydraulically formed with end plates brazed on.



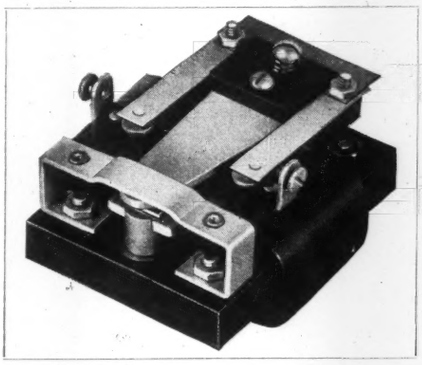
The Style "C" trap is of cast iron construction for pressures up to 200 lb, and made in angle type so trap drains itself when steam is turned off, desirable on outside installations as it prevents freezing. This trap also has the brazed bellows element. Valves and seats are of hardened stainless steel.—W. H. Nicholson & Co., 209 Oregon St., Wilkes-Barre, Pa.

Relay and Transformer Combined

No. 334—A low voltage transformer and a relay are so often used together in control circuits that it has been found desirable to combine them in a single unit to obtain economies in space, cost, and operating characteristics. The complete unit occupies a space of but 3" x 3¼" x 2¼". All current carrying parts

are insulated so that it may be attached direct to a metal case without insulating support. The device is rated at 15 amperes, 110 volts, a-c, and is available either as single pole double break or two pole single break.

Large silver contacts have a wiping action in closing. The relay completes half of its travel before the circuit is opened so that a quick break is secured. The current consumption of this device is less than is consumed by the two separate devices



that it replaces, according to the maker. Uses are in stoker controls, oil burner controls and various types of control equipment where a low voltage device, such as a room thermostat, a humidistat or limit control with its attedant low cost of wiring and installation expense are used to control line voltage equipment.—Russell Electric Co., 348 W. Huron St., Chicago, Ill.

New Diaphragm Valve

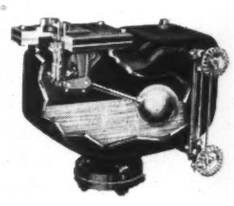
No. 335—Long range throttling top construction incorporates several new features of design, among which is the arrangement for adjusting the spring pressure. The member in contact with the bottom of the spring does not turn when the adjusting feed screw is turned but guided by the two vertical fins of the spider arms merely moves up or down. Thus spring adjustment does not tend to wind up the spring or disturb its normal characteristic in any way, states the maker.—C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.

Condensation Return Trap

No. 336—New trap functions to return water of condensation to the boiler without the use of pumps, and may be used in connection with low pressure heating, process or industrial installations where the operating pressure does not exceed 25 lb. Entirely automatic in operation.

Trap is installed at a suitable point adjacent to the boiler, above the water line. The condensation connection is connected with the lowest level of the return main below the water line. On either side of this connection, swing check valves are installed. A connection is made from the boiler proper to the steam inlet. The exhaust is then piped away to a stack or other convenient point.

Body is cast iron fitted with a companion flange to bolt onto the inlet opening. All mechanism is mounted on the head, which



permits easy access for repairs or adjustments. The trap is fitted with complete adjustment means to compensate for wear at the installation.—Jas. P. Marsh Corp., 2073 Southport Ave., Chicago, Ill.

Every part of Fairbanks U-O1 Bronze Globe and Angle Valves that is subject to excessive wear can be quickly renewed at small cost.

The asbestos disc can be renewed in a few minutes without removing the valve from the line. Any standard make of disc ring fits the slide-on disc holder. Disc nut throttles the action of the stream against the disc, prolonging its life.

The large hexes on union nut provide a firm grip for the wrench, permitting removal of bonnet without damage.

The radial seat between the body and bonnet is drawn to a tight joint by a union nut. This insures perfect alignment and decreased wear by eliminating sliding or scraping of the seating surfaces.

The stem has an average tensile strength of 65,000 lbs. and has a large number of Acme threads which give great strength and ease of operation.

The rugged, long lived and reliable performance of Fairbanks Valves reflect the care and enduring quality built into them.

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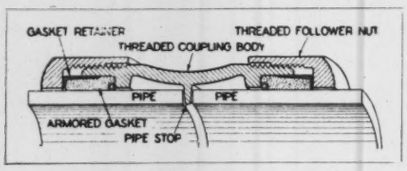
FAIRBANKS
GLOBE and ANGLE VALVES

New Type Pipe Coupling

No. 337—Several features are incorporated in new, self-contained "Style 65" pipe joint. To make a connection with this joint nothing is needed except the pipe (plain end), the joint itself and an ordinary wrench. Making the joint involves in-

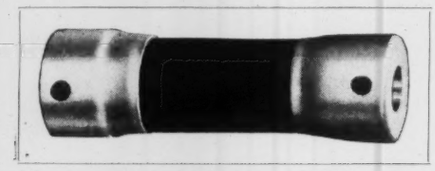


serting the pipe ends into the coupling (which comes assembled) and then tightening two threaded octagonal nuts. As the nuts are tightened, two resilient "armored" gaskets are compressed tightly around the pipe, gripping it and giving a positive seal.

These compression couplings are supplied, black or galvanized, in standard steel pipe sizes from ⅜ I.D. to 2 in. I.D. Applications are both inside and outside piping on gas, water, oil, air, chemical and industrial lines under high and low pressures.—S. R. Dresser Mfg. Co., Bradford, Pa.

Flexible Drive Coupling

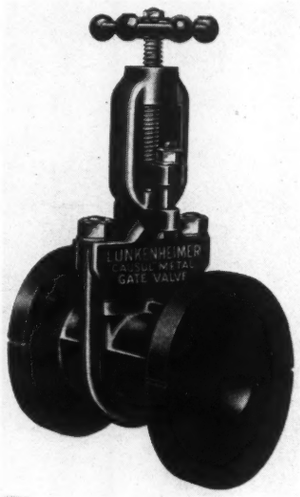
No. 338**—Improved drive coupling for fractional hp motors is designed to eliminate transmission of noise and motor torque vibration from the motor to the driven shaft; it is made of



flexible rubber, treated to resist action of oils, and offered in lengths from 2½ in. up, and with any combination of bores, 5/16, ⅜, 7/16 and ½ in. Has been applied to oil burners, stokers, etc. —Guardian Utilities Company, 1023 E. 46th St., Chicago, Ill.

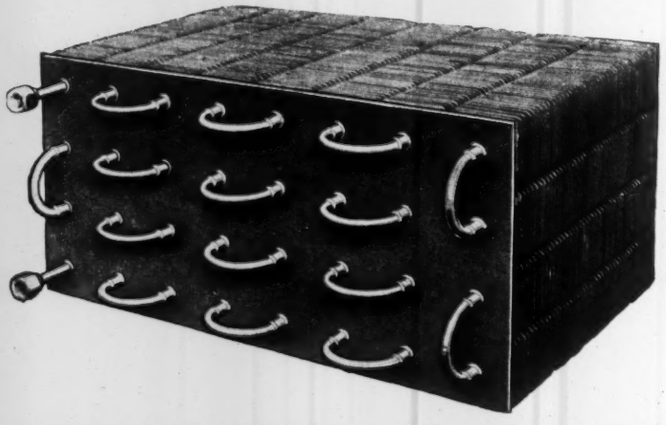
Gate Valve for Corrosive Service

No. 339—Chemical and industrial processes involve many corrosion resistance problems for which the new "Causul" metal valves, illustrated, are particularly adapted. They have been used successfully and economically for handling sulphuric acid, alkalis and many other corrosive fluids in the manufacture of



sugar, paper, textiles and rayon, rubber, caustics, fertilizer, in oil refineries, in coke and byproduct and water softening processes, etc., states the maker.

The metal is an austenitic ferrous alloy, particularly resistant to corrosion.—The Lunkenheimer Co., Cincinnati, Ohio.



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THE COIL ILLUSTRATED IS OUR TYPE 48. THIS TYPE ALONE CAN BE FABRICATED INTO MANY COILS EACH WITH A DIFFERENT FIN SPACING AND SURFACE AREA. WITH OUR MANY TYPES AND FIN SIZES, ANY OF WHICH CAN BE HAD IN VARIOUS COMBINATIONS, IT IS POSSIBLE TO SPECIFY A BUSH COIL WITH THE PROPER AMOUNT OF SURFACE FOR ANY INSTALLATION YOU MAY HAVE.

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Double Suction Centrifugal Pumps

No. 340**—A new line of double suction, single-stage split case centrifugal pumps is adaptable to practically any class of service; particularly recommended by the maker for general water supply in municipalities, industrial establishments, office buildings, and similar installations, due to their compactness and efficiency. The pumps are designed for any type of drive, including flat belt, V-belt, direct connected, gas or diesel engine, although the usual drive is connected directly to an electric motor. --Gardner Denver Co., Quincy, Ill.

Booklets, Reports and Papers

Commercial Standards for Fuel Oils

"Fuel Oils (Third Edition), Commercial Standard CS12-35," 16 pp., 6x9 in. For sale by the Superintendent of Documents, Washington, D. C., for 5c.

These specifications cover six grades of fuel oil for various types of oil burning equipment. General and detail requirements are given, significance of the prescribed tests is explained, and the history of the project is discussed. Included is a blank for acceptance of the standard, and a list of acceptors.

February 15, 1935, was the effective date for new production.

Body Heat Loss in Relation to Room Temperature

"Body Heat Loss by Radiation and Convection in Relation to Room Temperature," by T. Bedford. From the Proceedings of the Physiological Society, February 16, 1935. *Journal Physiology, Vol.* 84. *Approx.* 300 *words,* 1 *chart.*

From observations, and using an equation for the rate of heat loss from a blackened cylinder, rates of heat loss by radiation and convection at different room temperatures were estimated. Such values were calculated and are plotted in the diagram, together with data of Houghten and his colleagues. During the observations the relative humidity varied from 30 to 75 per cent, and averaged 47 per cent.

Pressure and Vacuum Gage Standard

"Proposed American Standard, Accuracy and Test Methods, Pressure and Vacuum Gages," in tentative form for discussion; criticism and comment will be welcomed. Copies available on application from C. B. LePage, Assistant Secretary, American Society of Mechanical Engineers, 29 W. 39th *St., New York, N. Y.*

The standardization of accuracy and test methods for pressure and vacuum gages is one of four subdivisions of the project assigned to the sectional committee on the standardization of such gages, which committee was organized under the procedure of the *American Standards Association* with the *American Society of Mechanical Engineers* as sponsor.

The tentative draft comprises the foreword, committee personnel, dial ranges and recommended ranges for various working pressures, requirements for accuracy for different services, method of expressing degree of accuracy, methods of testing (calibration standards and test procedure), and graduations, markings, and width and length of pointer.

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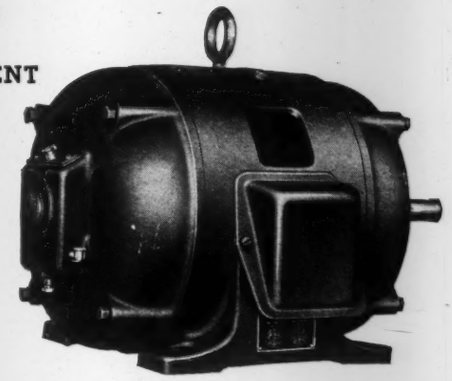
POLYPHASE
DIRECT CURRENT
CAPACITOR



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Refrigerating Machines .. Blowers
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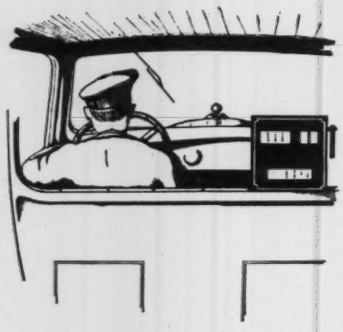

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STEAM doesn't stand still. It has to go somewhere to do its stuff. And an underground steam transmission line—like a taxicab—has a distance rate for conveying it. You can save one whale of a lot of money by taking the *right* taxi—Ric-wiL Underground Conduit—which cuts leakage and loss to the bone, and is "best in the long run."

The RIC-WIL Conduit System is certified for the highest known efficiency in the insulation and protection of underground steam lines. Made in a variety of types, materials, and insulating methods (including the famous waterproof asbestos RIC-WIL DRY-PAC), it secures satisfactory and economical results on *any* problem of underground steam transmission. Service is comprehensive in an engineering as well as manufacturing sense—from coast to coast. Write for details.

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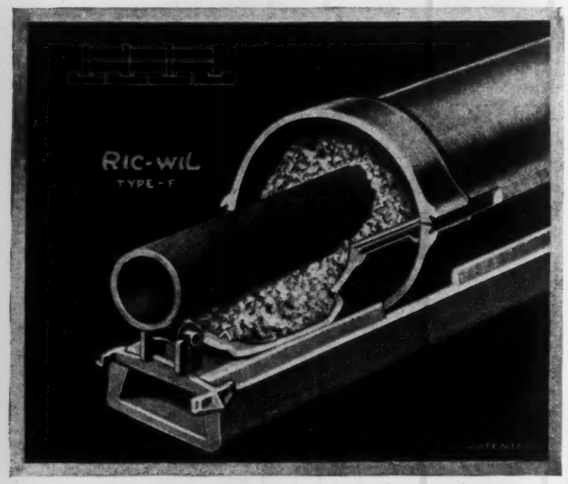
RIC-WIL DRY-PAC is pure asbestos insulation, which has certified conductivity of only .36 B.T.U. for low pressure.



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CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

Sources of Information on Coal

"A List of Books and Other Sources of Information Regarding Coal and Coal Products," compiled by F. R. Wadleigh. 63 pp., 6 x 9 in., paper cover. Obtainable from F. R. Wadleigh, Cecil Apartments, 1026—15th St., Washington, D. C. Price $1.

This booklet lists books and articles in the English language concerning coal, and tabulates articles dealing with coal and related subjects, the publications of technical societies and institutes, and the bulletins and reports of various universities and colleges. Listings show titles, authors, and when and where published.

The compiler is a consulting engineer, formerly chief of the coal division of the Department of Commerce, has been associated with the Bureau of Mines, and served at one time as Federal Fuel Administrator.

Book Reviews

Steam Heating

"Steam Heating," by Frederick W. Dye, Consulting Engineer, Member Inst. H. and V. E. 2nd edition, 1934. 203 + vi pp., 5x7½ *in., clothbound. Engineers Book Shop, 227 Park Ave., New York, N. Y.* $3.50.

The author describes the heating of buildings by steam, including one pipe and two pipe systems, high pressure steam, exhaust steam heating, vapor and vacuum systems, application of unit heaters, computation of radiation requirements, and the warming of factories and large open workrooms by means of overhead pipes. Chapters on water heating and cooking by steam are also included, as is a chapter on faults and miscellaneous information.

Although of interest to the latter, this volume is perhaps of greater utility to the British heating engineer rather than the American, as the practice of warming buildings by steam has not developed in England to the same extent as in this country, because of climate and other differences.

Fifty Year History of Hotels

"Hotel Red Book" (Golden Anniversary Edition), published by the American Hotel Association Directory Corp., 221 W. 57th St., New York, N. Y. 990 pp. $5

In addition to listing approximately 19,000 hotels in the United States and Canada, the publishers take advantage of this golden anniversary edition to picture the development of hotels during the past fifty years with articles of historic interest written by several authorities. A series under the general heading "50 Years Ago and Now" includes articles on hotel construction and equipment, travel and transportation, and other topics. Some thirty special articles present a most interesting picture of early hotel days.

Conventions and Expositions

American Welding Society: Fall meeting, Chicago, Ill. Sept. 30. Secretary, W. Spraragen, 29 W. 39th St., New York, N. Y.

Midwest Power Show: October 14-18, Chicago, Ill. G. E. Pfisterer, Managing Director, 1 N. LaSalle St., Chicago, Ill.

American Gas Association: Annual convention, October 14-18, Atlantic City, N. J.

International Heating & Ventilating Exposition: January 27-31, International Amphitheater, Chicago, Ill. Manager, Charles F. Roth, Grand Central Palace, New York, N. Y.

American Society of Heating and Ventilating Engineers: Annual meeting, January 27-31, Palmer House Hotel, Chicago, Ill. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

Imperial motors are built in ratings from 1/2 to 300 hp. in all types.

You Can Hardly Hear It Run!

Imperial pioneered the quiet operating motor . . . and when we say quiet operating, we mean a motor so quiet that you can hardly hear it run.

Every detail of Imperial's new ultra-modern line of standardized dimension motors was designed for noiseless operation without sacrifice of other desirable features.

Noiseless operation is a mighty important feature in motors for air conditioning work . . . that's why architects, manufacturers and contractors are figuring Imperial motors for compressors, fans, blowers, and pumps.

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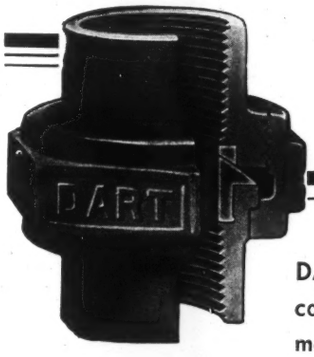

DART UNIONS have become "Standard Equipment" for all better pipe line installations . . . their Bronze to Bronze seats will never corrode . . . their Rugged construction never gives out . . . they complete a strong, efficient, and trouble-free pipe line.

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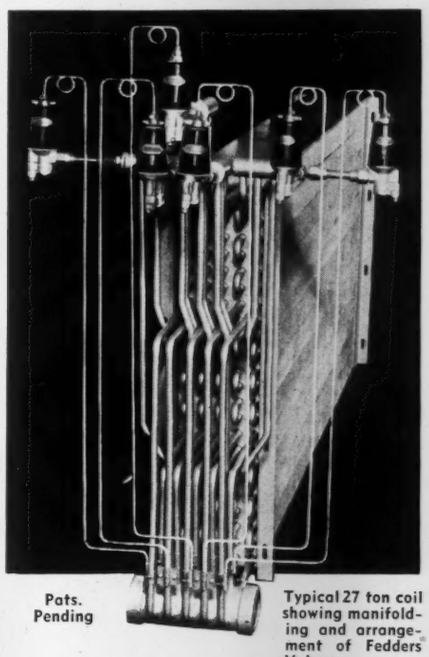
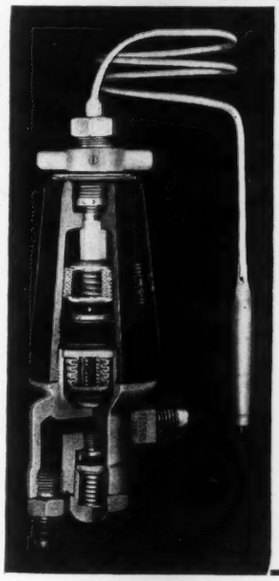
How Fedders Factory Manifolding *Eliminates* DIFFICULTY HAZARDS and EXPENSE *of* Field Assembly of Coils *for* AIR CONDITIONING



Pats. Pending

Typical 27 ton coil showing manifolding and arrangement of Fedders Valves.

When you buy Fedders Coils, you get far more than rows of tubing with fins on 'em. Fedders gives you a COMPLETE low-side with manifolds factory engineered and installed. You get correct refrigerant distribution, effective heat transfer, and save installation time and expense. The complete unit is tested and dehydrated,—ready to hook up on the job. When in the market for air conditioning coils be sure to realize the importance and economy of Fedders scientifically designed manifolded coils. Cataloged on a "package basis," write for Bulletin 91.



BELOW: Cutaway view of Fedders Valve showing large refrigerant passageways.

FEDDERS
High Capacity
THERMOSTATIC EXPANSION VALVE

Its easy, sensitive adjustment assures obtaining a well balanced condition throughout the entire coil and between low-side and high-side.

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The latest scientific method of economically and efficiently heating an industrial building.
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A most efficient hot-air generator, combining fan and heater units Temperature and air volume under positive manual or automatic control.
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PRODUCTS

Recent · Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 97

No. 470. AIR CONDITIONERS: Savage Arms Corp., 100 E. 42nd St., New York, N. Y. Leaflets describing "Zephyr 60 and 61" all-year air conditioners, the former self-contained including refrigeration and the latter for cooling with chilled water or remote refrigeration. These units include water spray for year 'round cleaning, cooling and dehumidification in summer, and humidification in winter.

No. 471. AIR CONDITIONING: Kelvinator Corp., 14250 Plymouth Rd., Detroit, Mich. Eight page folder describing the advantages of air conditioning for offices and homes illustrating various installations and several of this company's sixty-three units; leaflet featuring air conditioning for perfect comfort describing the advantages of "exact selection" of air conditioning equipment; eight page folder discussing air conditioning as a business builder describing the advantages of air conditioning in stores, shops and other commercial buildings.

No. 472. AIR CONDITIONING: The Trane Co., La Crosse, Wis. Four page folder "Spotlight Your Theater," describing the advantages of air conditioning movie theaters.

No. 473. BEARING MOUNTINGS: The Bearing Appliance Co., Ardmore, Pa. Twelve page bulletin on standard appliances for anti-friction bearing mountings with complete discussion and tabular data.

No. 474. BOILERS: Fitzgibbons Boiler Co., Inc., 570 Seventh Ave., New York City. Leaflet featuring oil burner boiler units in 13 different sizes from 425 to 2680 sq ft E. D. R.

No. 475. BOILERS: National Radiator Corp., Johnstown, Pa. 28 page catalog of steel boilers, 485 to 2500 sq ft radiation, describing features, showing interior and exterior views of commercial and residential series and giving engineering data, capacity tables, etc., for the various types, including solid fuel fired and oil fired.

No. 476. CAPACITORS. General Electric Co., Schenectady, N. Y. 26 page booklet on improving power factor for profit and describing "Pyranol" capacitors. Complete information on the equipment is included together with a section on application of capacitors with graphs and tables.

No. 477. COMFORT COOLERS: The Trane Co., La Crosse, Wis. Four page bulletin describing features of propeller type, suspended comfort coolers (chilled water or direct expansion) for air conditioning, with roughing-in dimensions, tables of cooling and heating capacities with direct expansion, chilled water, brine, or hot water.

No. 478. COMPRESSORS AND VACUUM PUMPS: Ingersoll-Rand Co., 11 Broadway, New York, N. Y. 32 page catalog of "Type 30" industrial compressors and vacuum pumps, ¼ to 15 hp, pressures up to 1000 lb, of various types and with different types of drives.

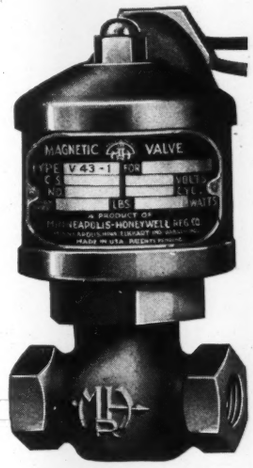
No. 479. CONVECTORS: Commodore Heaters Corp., 11 West 42nd St., New York, N. Y. 12 page booklet on convectors or built-in radiators for steam vapor and vacuum heating systems, including single pipe steam heating systems. The equipment is described and illustrated, installation pointers are given, figuring heating requirements is explained, and tables of effective heating capacities are given for selection of heaters.

No. 480. DUST COLLECTORS: Pangborn Corp., Hagerstown, Md. Folder describing new cloth screen dust collector and announcing publication of new bulletin on collection of dust.

AIR CONDITIONING CONTROLS

for

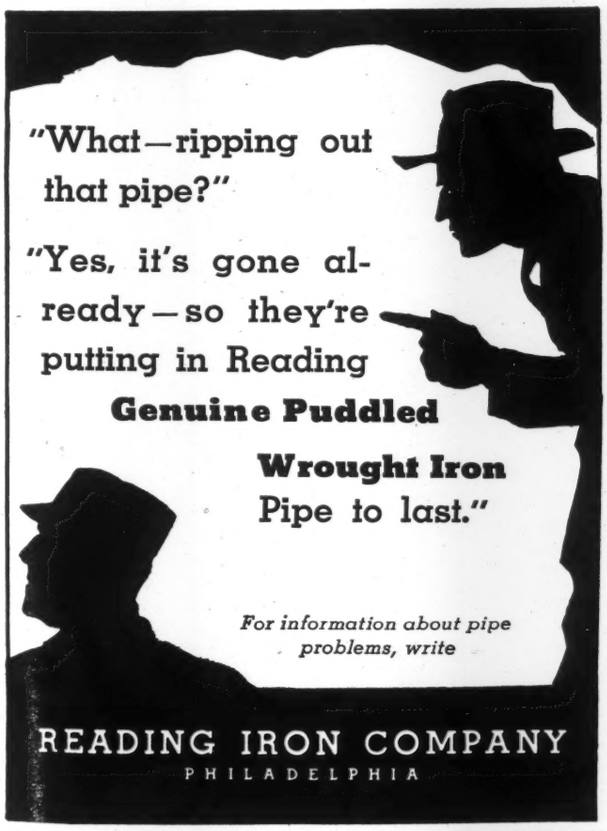
Domestic or Commercial Installations



Magnetic Shutoff Valve. Silent Solenoid valve with replacement seat and plunger. Especially designed for domestic air washers.

MINNEAPOLIS-HONEYWELL Air Conditioning Controls govern all phases of this work, including heating, cooling, ventilating, humidifying or dehumidifying. There are controls for every application, each designed to accomplish its particular function with characteristic Minneapolis-Honeywell accuracy and efficiency. Minneapolis-Honeywell Regulator Company, 2701 Fourth Avenue South, Minneapolis, Minn. Branch and distributing offices in all principal cities.

MINNEAPOLIS-HONEYWELL
Control Systems



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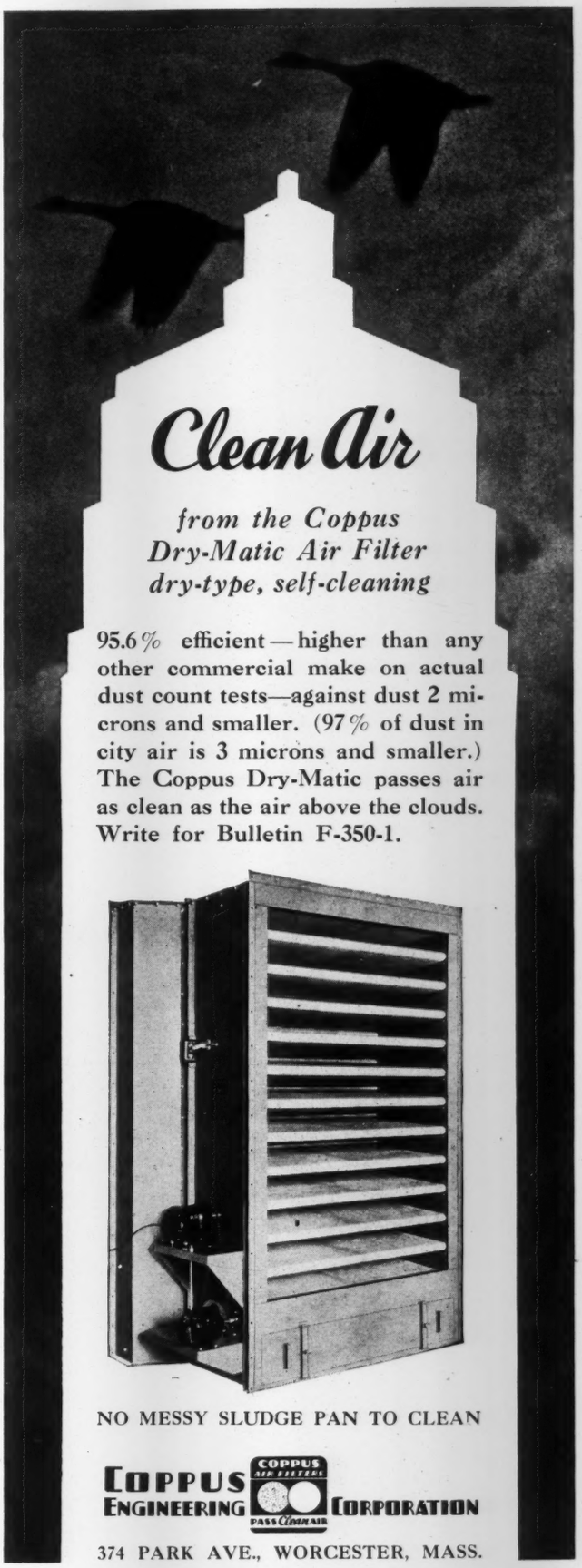
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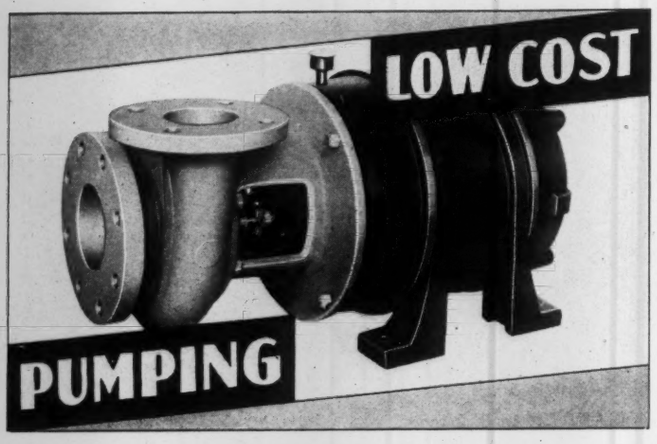

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No. 481. EXPANSION JOINTS: Ross Heater & Mfg. Co., Inc., Buffalo, N. Y. 28 page bulletin describing application and use of expansion joints and giving specifications and dimensions for standard and extra heavy flanged and welded crosshead guided types, internally guided, and other types, with data on pipe line expansion, etc.

No. 482. FUSE PULLER AND TEST LIGHT: Ideal Commutator Dresser Co., Sycamore, Ill. Leaflet describing pocket size tool resembling a pair of pliers for testing fuses before pulling them; 110 to 550 volts, 30 to 100 amperes.

No. 483. GAGES: The Hays Corp., Michigan City, Ind. 24 page catalog featuring pointer types of indicating and recording gages for draft, pressure, differentials, and temperature and discussing the advantages of modern instruments, describing the various instruments in detail; included are gages for indicating resistance through air filters, refrigeration coils, or boiler passes.

No. 484. HUMIDITY CONTROL: Julien P. Friez & Sons, Inc., 4 N. Central Ave., Baltimore, Md. Four page bulletin on wall mounted and insertion type humidistats for automatic control of relative humidity in comfort and industrial air conditioning applications, describing the instruments, giving instructions and list prices.

No. 485. LIQUID LEVEL CONTROLLERS: H. Belfield Co., 435 N. Broad St., Philadelphia, Pa. 24 page bulletin illustrating and describing liquid level controllers and accessories with numerous sketches showing typical applications.

No. 486. METERING: The Bristol Co., Waterbury, Conn. Eight page technical bulletin on telemetering pressure, liquid level, temperature, flow and motion with simple two-wire circuit, describing features of equipment, principle of operation, typical uses, etc.

No. 487. OIL SECTIONS AND ACCESSORIES: Ross Heater & Mfg. Co., Inc., Buffalo, N. Y. 36 page bulletin on "Sterling" oil sections for condensing petroleum distillates in oil refineries and for general use in absorption plants.

No. 488. PIPE: Ross Heater & Mfg. Co., Inc., Buffalo, N. Y. 12 page bulletin describing "Arco" metal pipe, nipples and couplings and applications in the petroleum and chemical industries, including information on cutting and threading, welding, and special coil assemblies.

No. 489. PRESSURE REDUCING VALVES: H. Belfield Co., 435 N. Broad St., Philadelphia, Pa. 36 page bulletin of pressure reducing valves and pump regulators describing the various types, giving dimensions and information on performance together with typical applications.

No. 490. PUMPS: Worthington Pump and Machinery Corp., Harrison, N. J. Six page bulletin on horizontal duplex piston pumps, turret types, for handling liquids at 200 lb per sq in. with specifications, dimensions, and size and capacity tables.

No. 491. REFRIGERANTS: R. & H. Chemicals Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. May, 1935 issue of "Artic Service News" including information on methyl chloride, the drying of methyl chloride systems, etc.

No. 492. REFRIGERATION AND AIR CONDITIONING: Fedders Mfg. Co., 57 Tonawanda St., Buffalo, N. Y. Booklet of articles on refrigeration and air conditioning problems by Joe Askin, Chief Engineer of this company. Included are articles on flat fin evaporators, thermostatic valve capacity, installation of unit coolers, selection of unit cooler and high side, selection of non-frost evaporators, installation and adjustment of cooling units and evaporators, uses of constant pressure valve, snap action valve and check valve, selection of coils for air conditioning, and figuring cooling and dehumidifying coils for air and refrigerant conditions other than standard.

No. 493. RELAYS AND CONTROL ASSEMBLIES: Julien P. Friez & Sons, Inc., 4 N. Central Ave., Baltimore, Md. Data sheet describing and illustrating relay and control assemblies for use in conjunction with this company's humidistats, thermostats, etc., including booster relays, two-wire transformer sets,

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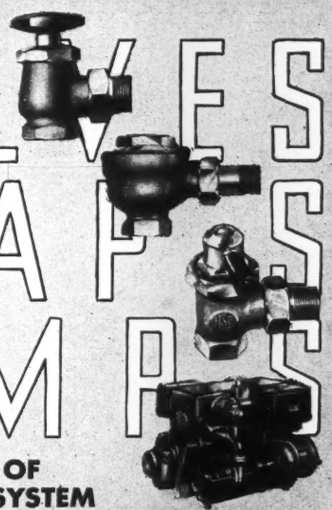

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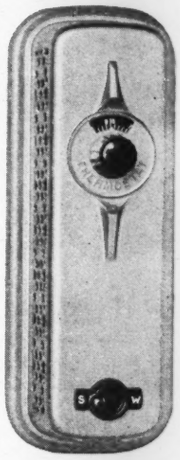

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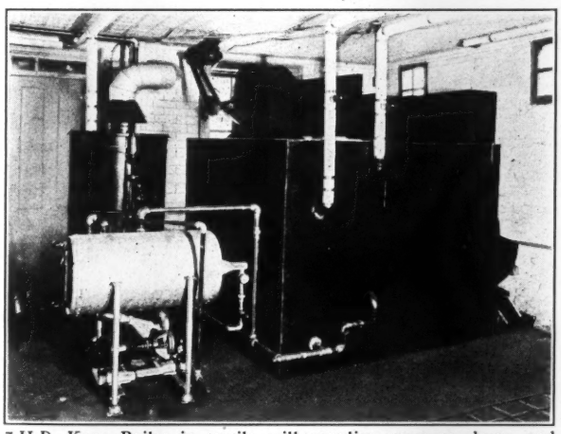

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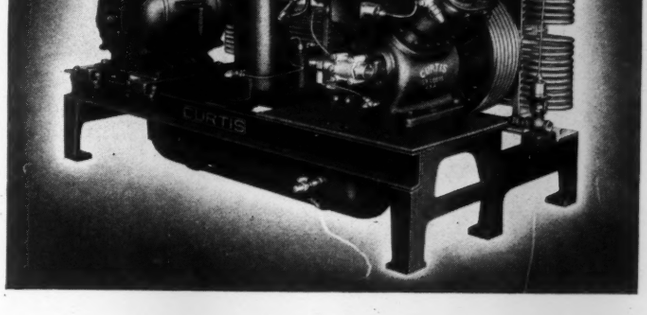

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No. 494. SPRAY NOZZLES: Binks Mfg. Co., 3106 Carroll Ave., Chicago, Ill. Eight page bulletin describing and giving capacity tables for spray nozzles for industrial uses, including brine refrigeration, air conditioning, water cooling, spray drying, humidifying, ice melting and others. Numerous illustrations and diagrams are included.

No. 495. STAINLESS STEEL: Republic Steel Corp. (Central Alloy District), Massillon, O. Six page folder describing use of "Enduro" stainless steel for textile plants, including dye kettles, dye racks, and various other equipment. An interesting feature is a series of color illustrations of yarn samples dyed in acid color and in acid chrome color to show how this stainless steel holds the true color of the dye.

No. 496. STEAM CONDUIT SYSTEMS: H. W. Porter & Co., 825 Frelinghuysen Ave., Newark, N. J. Eight page well illustrated booklet describing "Therm-O-Tile" underground steam conduit system for the protection, support and insulation of underground pipe lines—hot or cold—describing features of the system in detail.

No. 497. STEAM HEATING: Gorton Heating Corp., Cranford, N. J. Four page bulletin describing equalizing valves to promote quick and even heating of radiators and air eliminators for quick venting of steam mains.

No. 498. STEAM JET REFRIGERATION: Ross Heater & Mfg. Co., Inc., Buffalo, N. Y. 32 page booklet entitled "Cooling with Steam" giving information on this company's "Decalorator," fully describing the principle of operation, the various parts of a steam jet refrigeration machine, temperature control, steam and water consumption, liquid cooling by direct flashing, and giving information on typical piping layouts, specifications and capacity tables for the various units.

No. 499. STEAM TRAPS: Armstrong Machine Works, Three Rivers, Mich. Issue of the "Armstrong Magazine" (No. 3, 1935) including first of a series of articles on return systems for returning condensate to boilers, and other information on steam traps.

No. 500. STORAGE WATER HEATERS: American District Steam Co., North Tonawanda, N. Y. Eight page bulletin giving complete information on horizontal U-tube type storage water heaters for large buildings and plants with general information on estimated hot water demand, amount of storage required and complete data on storage tanks and storage water heater elements.

No. 501. STORAGE TANK HEATERS: Ross Heater & Mfg. Co., Inc., Buffalo, N. Y. 16 page bulletin describing material and construction of storage tank heaters and giving tables of dimensions and specifications for various types, conversion tables for determining heating capacities, tables of hot water requirements in various types of buildings, and a chart for determining size of steam piping required.

No. 502. TEMPERATURE AND PRESSURE CONTROL: Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn. Four page bulletin describing "Controlograph" with 10-in. diameter recording chart for controlling and recording temperatures and pressures.

No. 503. TEMPERATURE CONTROL: Hart Mfg. Co., Hartford, Conn. 20 page booklet of temperature control equipment including direct break indicating thermostats, direct break non-indicating thermostats, water heater thermostats and two-rate electric water heater control. Information on use of each instrument is included and installation drawings are shown.

No. 504. UNIT HEATERS: Buckeye Blower Co., Columbus, O. 24 page catalog of floor type unit heaters embodying high velocity discharge, large air volume, and low temperature rise; with or without temperature control damper and outdoor intake. Features and construction of the units are described, dimension drawings are given, and capacity tables are presented. Also, 16 page booklet giving capacity tables for suspended type unit heat-

ers, information on location, selection chart, dimensions, piping diagrams, etc.

No. 505. VALVES AND FITTINGS: Mueller Brass Co., Port Huron, Mich. 72 page catalog of valves, flared tube fittings, manifolds and strainers, etc., for refrigeration, gas, oil, air and vacuum lines with large dimensioned illustrations of the equipment, physical specifications, and engineering specifications.

No. 506. VENTILATOR AND FILTER UNITS: Truscon Steel Co., Youngstown, O. Four page bulletin describing window ventilator and filter units for offices, and homes.

No. 507. WATER TREATMENT: Rathbun Co., Inc., El Paso, Tex. Bulletins on boiler feed water treatment for high and low water pressure boilers; treatment of cooling water for prevention of scale, rust and corrosion in condensers, compressors, air washers and humidifiers, and refrigerating plants; water problems in the ice and refrigeration industry; and water treatment for hot and cold water and drinking water distribution systems.

No. 508. WELDING ELECTRODES: Metal and Thermit Corp., 120 Broadway, New York, N. Y. 16 page booklet on "Murex" heavy mineral coated electrodes including technical data, principles of design and operation, physical properties and chemical analyses of deposited metals and pictures of various applications. Features of these electrodes include patented spiral winding of asbestos yarn which anchors the extruded coating to the core wire, assures uniform coating thickness and prevents wandering of the welding arc. Included is a section on electrodes for welding the new steels.

No. 509. WINDOW VENTILATOR AND FILTER UNITS: Kaiseraire Products Sales Co., 936 W. Chicago Ave., Chicago, Ill. Leaflet describing filter ventilator unit for window installation for relief from hay fever and pollen asthma, in two sizes, the first of which delivers from 50 to 200 cfm of air and the larger 100 to 400 cfm.

No. 510. WOOD PIPE: A. Wyckoff & Son Co., 12 Home St., Elmira, N. Y. 92 page book on wood pipe describing its uses, history, durability, carrying capacity, asphalt coating, stave construction and applications to numerous industries. Fittings and special connections, valves, etc. are also described and illustrated. A special section is devoted to cypress steam pipe casing and stave steam pipe casing. The appendix contains pertinent technical information.

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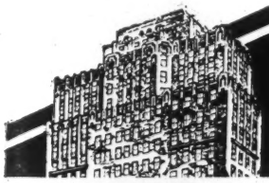

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